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CRAB APPLES FOR WILDLIFE FOOD[1]

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ABSTRACT

In 1956 observations were started on the fruit persistence of crab apple trees, mainly in horticultural collections, to determine which had fruit regularly persisting until mid- or late winter and to observe wildlife use of the fruit for food. Records were made on several hundred individual trees, for 103 of which sufficient information was obtained over several years to serve as a basis for judging their value for wildlife use. Selections from these were top-worked by grafting onto volunteer apple trees on the Partridge Run Game Management Area, so that wildlife use could be followed. The characteristics of the crab apples recommended for wildlife food are described. Of these, 25 clones or individual kinds that must be propagated by grafting were selected, on the basis of adaptability, consistent fruit production, persistence of fruit and use by wildlife, for establishing scion-wood orchards in the various game management regions. Use of such stock in providing food for wildlife is discussed.

The fruit of apple trees has been used for food by humans as well as by birds and animals since ancient times. When the Europeans came to the temperate parts of the New World they found several species of native apple trees, but none was particularly palatable, so cultivated forms were brought from Europe to supply the fruit to which they were accustomed. The common apples, grown as seedlings or as grafted and budded plants, and the small-fruited crab apples were spread across the nation by orchardists and nurserymen; the family or "home" orchard became an essential part of the nineteenth century farm in the United States and Canada where the climate was suitable. Passage of the seeds

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through cattle enabled apple trees to become established in almost every pasture and hedgerow, until the common apple came to be looked on as though it were a native.

When China and Japan were opened to European and American plant explorers, the many small-fruited apples generally referred to as "flowering" or "ornamental" crab apples slowly became known to the Western world. Largely from the botanical collections in the Arnold Arboretum at Jamaica Plain (Mass.) and in the Rochester (N.Y.) parks, these were disseminated to nurserymen and from them to the public. Hybrids occurred naturally, and others from controlled crosses, to produce many outstanding ornamentals with attractive flowers and fruit.

The U.S. Soil Conservation Service made numerous experimental wildlife plantings of seedling crab apples in the Northeast beginning about 1937 (Edminister and May, 1951). Species planted were: Siberian crab (*Pyrus baccata*) and its Manchurian variety (var. *mandshurica*), Japanese crab *(P. floribunda)*, Sargent crab *(P. sargenti)*, Toringo crab *(P. sieboldi)* and Zumi crab *(P. zumi)*. Survival varied from poor to excellent; growth, from very slow to good; fruit production, from none to heavy. There was some use of fruit by pheasants, but much damage to the seedlings was caused by deer and rabbits. The conclusion was that none could be recommended at that time for wildlife plantings.

Wyman (1955) described over 280 crab apple species, varieties and clones being grown in arboretums and botanical gardens, or offered for sale commercially, in the United States and Canada. By means of bar graphs, the dates between which fruits are colorful, from August through February, were shown for 77 species, varieties and clones, indicating that some hold their fruits longer than others. The clone 'Bob White' was described as being one of the few to hold its fruit all winter.

The writer's attention was called to the persistence of the fruit of crab apples, and their use for food by wildlife, in January 1950 when two crab apple trees were noted in a pasture near Rexford in Saratoga County (N.Y.) still heavily laden with the frozen pomes which were being eaten by pheasants, grouse, squirrels and wintering birds, as well as by cottontail rabbits and deer as the fruit slowly fell from the trees. Between then and June 1960, when a tornado destroyed the two trees, fruiting was heavy every year except one when late May frosts inhibited pollination.

The 'Bob White' crab, presented to the Arnold Arboretum in 1876, was named because the bobwhite quail made use of the small pomes for food. In more recent decades, pheasants have used the fruit (Wyman, 1956). The writer first saw a plant of this clone in Rochester (N.Y.) in January 1955, heavily laden with fruit which was being eaten by pheasants, squirrels, bluejays, cottontails and numerous small, wintering birds.

METHODS AND PROCEDURES

The present study was started in the fall of 1956, as a part of observations on trees, shrubs and vines for annual fruit production, persistence on the branches and use by wildlife. The purpose of examining the apples as a group was to find clones[2] or individuals with the following characteristics:

1. Annual, rather than alternate-year, production of large volumes of fruit.
2. Persistence of the fruit on the branches during the winter, rather than dropping to the ground in the fall so that winter snow and ice would bury it out of reach.
3. Use by wildlife, during the season of general fruit scarcity (i.e., winter), rather than in the fall when a great abundance of fruit would normally be available.

Examination of the commercial forms of apples soon showed that nearly all fruit, if not harvested, would be on the ground before late November. Commercial orchard trees require periodic fertilization and annual pruning to shape the trees, to eliminate sprout growth and to concentrate the energy of the trees in a relatively few branches so that fruit will be large and ripe by harvest. Commercial orchards require numerous sprayings to control such diseases as apple scab and fire blight and many species of insects and mites. Neglect of this intensive care normally results in non-marketable fruit, and the orchards may soon cease bearing.

The ornamental crab apples, by contrast, are relatively resistant to many of the diseases and parasites of the common apple (Wyman, 1956). More recently, Chadwick and Nichols (1965) and Simpson (1967) have evaluated the disease resistance of crab apples, showing clonal as well as regional variations in resistance to leaf spot, mildew, fire blight and apple scab.

Observations, therefore, were concentrated on the crab apples, starting with the arboretum plantings in Highland and Durand-Eastman Parks in Rochester (N.Y.) and at the Arnold Arboretum at Jamaica Plain (Mass.). Beginning in October 1956 when some seeds were collected at Rochester, and through making winter visits from January to April, records were made of fruit production, relative volume, fruit persistence and use by wildlife. Crops were rated by eye as good (heavy to moderate), fair, poor or none produced. The volume of fruit remaining on the tree was rated as good, fair, poor to scattering or none. Wildlife use was determined by direct observation of animals and birds as well as from feeding signs, tracks and the reports of other observers.

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[2]A clone is a plant developed by vegetative propagation rather than from seed.

Requests were circulated to Conservation Department personnel for reports of fruit persistence and wildlife use. When nearly all the reports received turned out to involve trees obtained from commercial sources and planted for their ornamental qualities, this approach was dropped in favor of concentrating on the large collections where the crab apple species, hybrids and named clones were growing and properly identified.

The seedling apple orchards at the New York State Agricultural Experimental Station at Geneva also were examined during several winters for persistent-fruited individuals.

Several hundred seedlings were produced from the 1956 seed collection. These were lined out for observation at the Painted Post Shrub Nursery, the Wildlife Research Laboratory at Delmar and the Partridge Run Game Management Area. It soon became apparent that these would require several years of growth before fruiting would occur, so this method was discontinued.

Beginning in 1957, scion wood of persistent-fruited crab apples was obtained from the Rochester parks and from the Arnold Arboretum. The scion wood was used to top-work volunteer apple trees in the abandoned pastures on the Partridge Run area and at the Wildlife Research Laboratory (Smith, 1963). As the grafts took control of the trees and started fruiting, records were made of the general volume of fruit produced each year, persistence of fruit and wildlife use. In early November 1970, all pomes were picked from two vigorously growing grafted trees. All pomes from a tree of 'Donald Wyman' (grafted in 1958) were weighed in bulk but were not counted. All pomes from a tree of 'Niska Nugget' (grafted in 1959) were counted but not weighed in bulk. Twenty lots of 100 pomes each from each tree were weighed to determine the mean weight per pome and, by calculation, either the total weight or the total number of pomes on each tree.

In 1957 and 1958, when scions failed to grow and the sucker shoots were taking over below the deadened branch end, attempts were made to rework the branch by inserting buds at the bases of the sucker shoots. While successful, this method proved too slow and required too much pruning for several seasons to force growth in the established buds by eliminating competing unbudded sprouts.

Commercially available clones were purchased and planted on the Partridge Run area. Trunks of trees were protected with quarter-inch-mesh hardware cloth cylinders, closely but loosely wrapped to protect against mice, cottontail rabbits and woodchucks. When deer began browsing in all seasons on the new growth, cylinders of 1 x 2-inch-mesh fencing were put around the trees to heights of 4, 5 and even 6 feet to keep the deer away until the plants could grow tall enough to permit pruning away the lower branches to a height of 6 feet or more. Individual plants were limed and fertilized, and mulched with old manure

to encourage growth. Because of poor growth, and the cost of providing protection for these plants (Smith, 1963), planting of purchased trees on the Partridge Run area was halted.

As top-worked plants began to provide scion wood for other grafting work, and as these began to fruit and provide observations on wildlife use of the fruit, purchase of plants was limited to new clones not otherwise obtainable. These were planted as stock plants at the Painted Post nursery and used to provide scion wood for grafting and budwood for creating other stock plants.

In order to build up a supply of scion wood and budwood of the clones known to produce persistent fruit used in winter by wildlife, commercial apple seedlings were purchased and lined out in rows in the spring of 1958. In August 1958 and again in 1959 these were used as understocks for budding 28 of the persistent-fruited crab apple clones. Some of these were set out as stock plants at Painted Post, while a small distribution (one or two plants) of 18 different clones was made to the State's nine game management regions in the spring of 1963.

In 1965 seedlings of the Toringo crab, a regular production item at the Painted Post nursery, were lined out and used in August of that year for understocks on which to bud 25 each of 23 different clones. Additional seedlings were lined out in 1966 and used as understocks for budding additional plants of 12 clones previously budded in 1965 and for 11 new clones.

By the fall of 1967, plants budded in 1965 were large enough for distribution as stock plants, and the establishment of scion-wood orchards in the game management regions was undertaken. Because deer damage would be a problem on the areas available, fencing materials were purchased and distributed in 1968 for erecting enclosures to protect the trees from deer, rabbits and woodchucks. The following spring, 23 different crab apple clones, one to three trees of each kind, were distributed to eight regions. These orchards are furnishing scion wood for use in game management programs over the State.

FINDINGS

Table 1 summarizes observations on the persistence of crab apple fruit on the branches, beginning in October and continuing at intervals until, in some cases, fruit was still present when new leaves and flowers appeared in the spring. Individual plants or clones named in honor of persons or objects are capitalized and enclosed in single quotation marks. Others are designated by their specific name in italics.[3] Following a name usually is a number preceded by a designation for the collection from which the clone was obtained or where it was observed: AA — Arnold

[3] All apples are presently considered as belonging to the genus *Pyrus*.

Table 1. Fruit Persistence in Crab Apples*

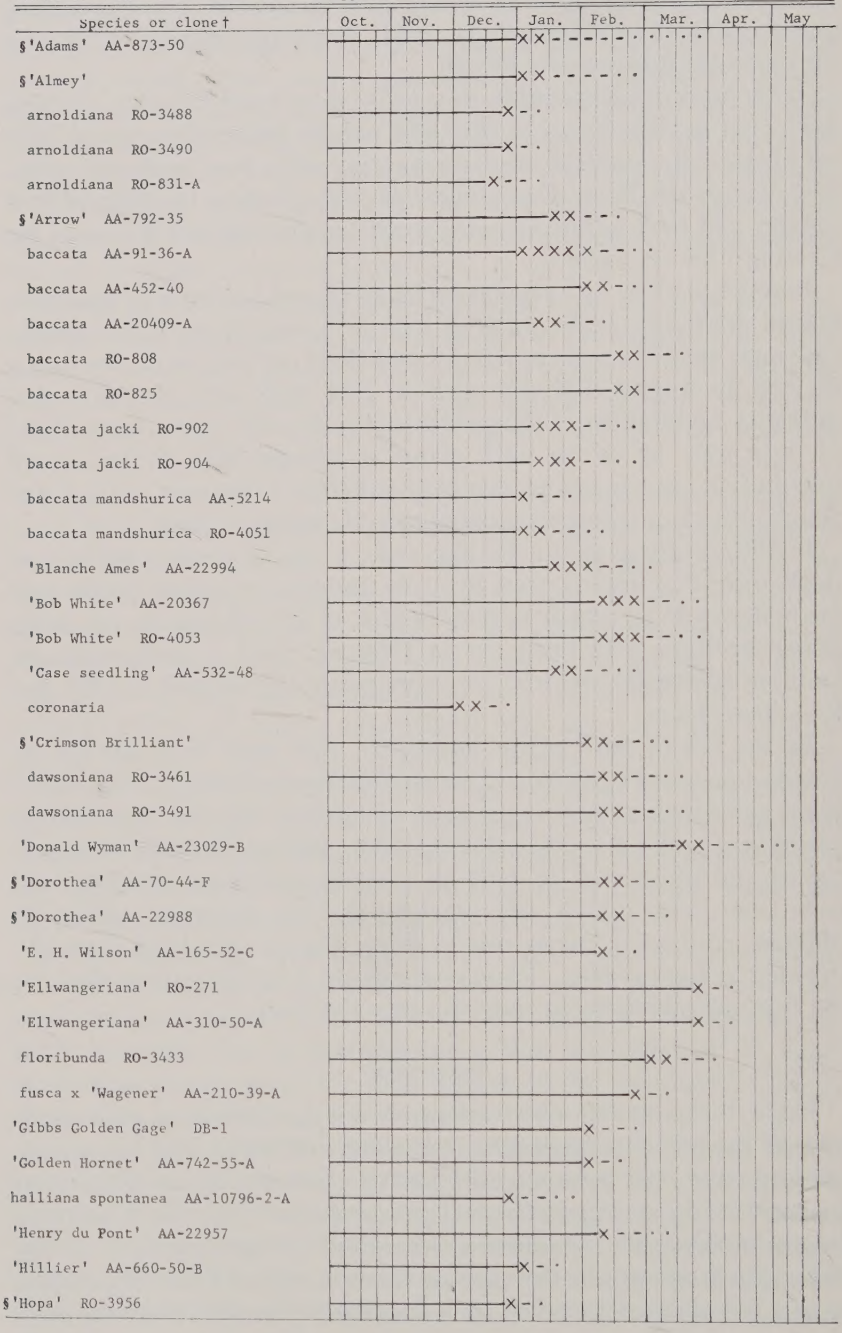


Table 1. (continued)

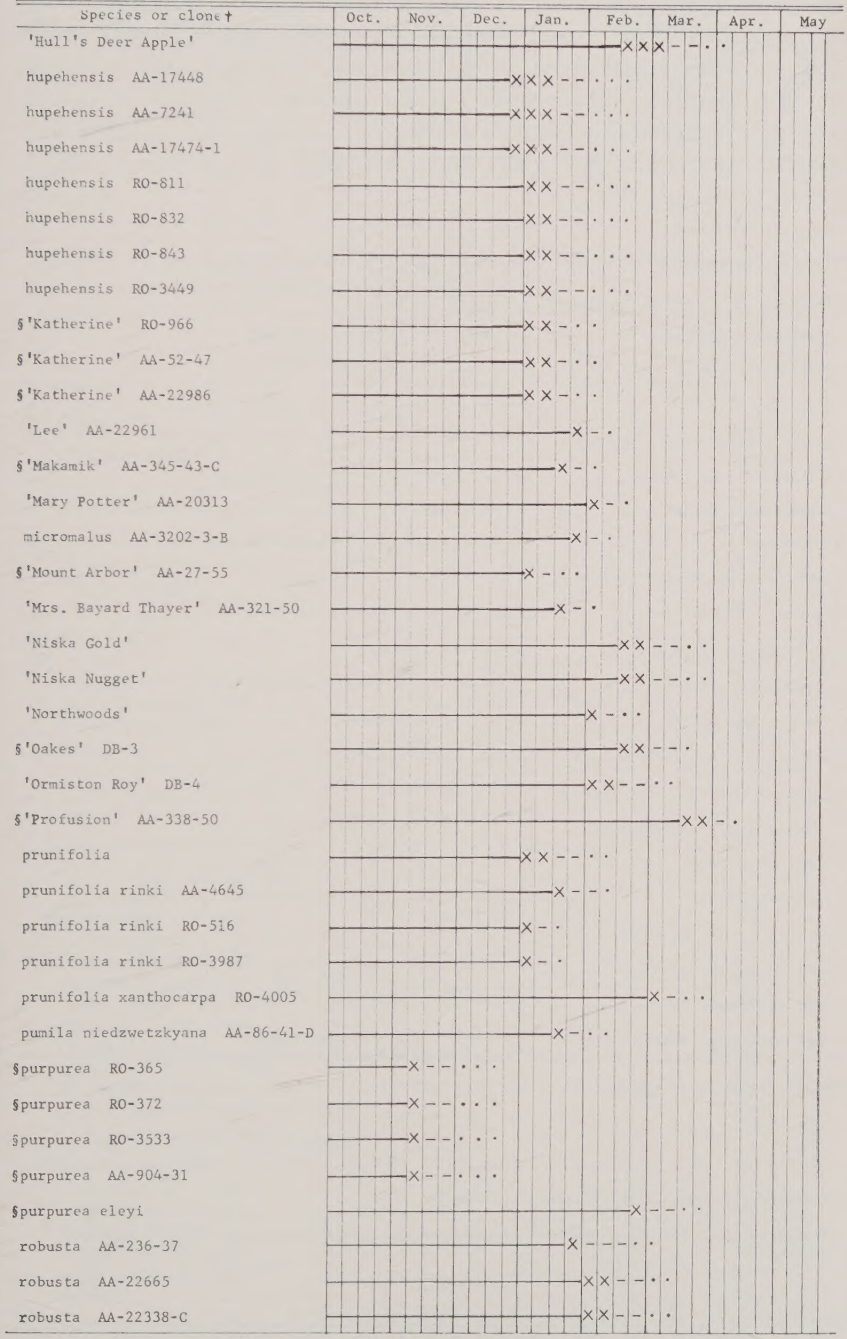
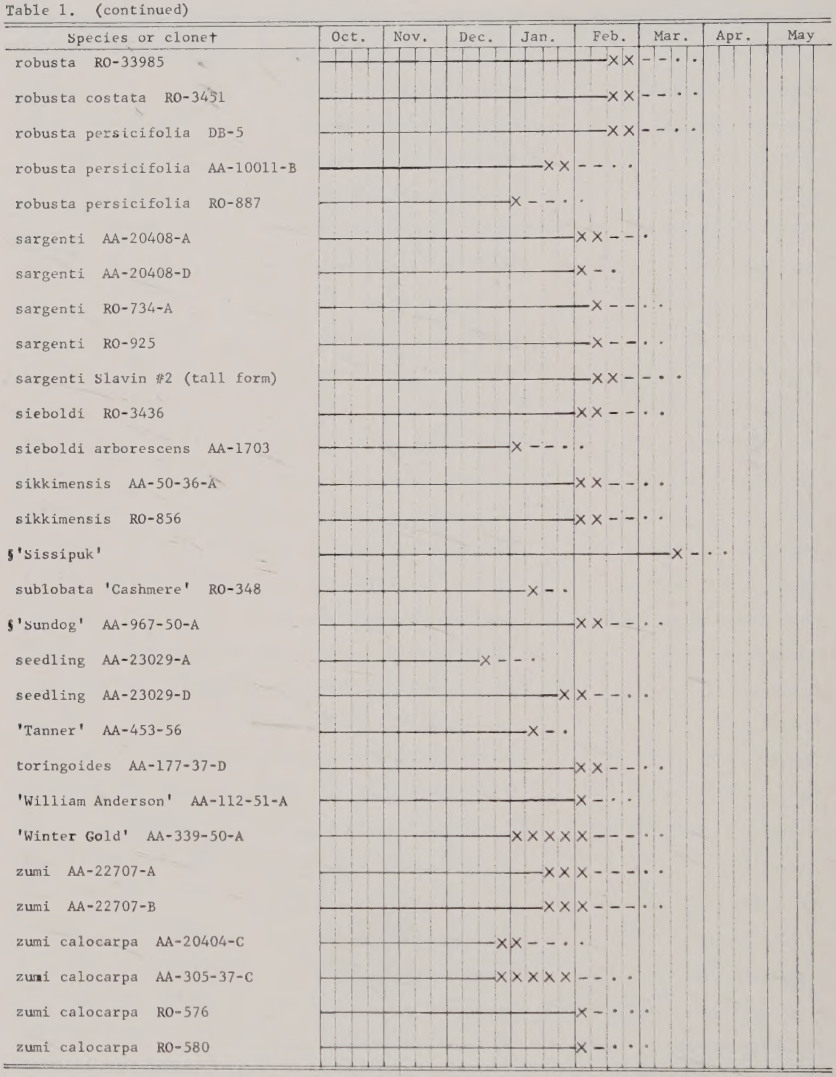


Table 1. (continued)



*Based, in part, on Wyman (1955). Symbols represent: ——— nearly all fruit persisting
XXX 3/4 of fruit persisting
– – – 1/2 of fruit persisting
• • • 1/4 or less of fruit persisting

†See text for explanation of reference numbers.

§Indicates clone with pink, carmine or red flowers, generally obtainable from commercial nurseries.

Arboretum; RO — Rochester parks; DB — plants supplied as scion wood by the late A. F. den Boer of Des Moines (Iowa). Plants listed without numbers were obtained commercially or were found growing spontaneously. Different numbers for the same name designate different individual plants, examined to ascertain possible differences because of origin as seedlings or when the same clone was planted in different locations.

TABLE 2. CRAB APPLE CLONES RECOMMENDED FOR WILDLIFE PLANTINGS, GROUPED ACCORDING TO DIAMETER OF FRUIT*

Diameter group (centimeters)	Average diameter (centimeters)
3.6 and over (1 13/32 inches)	
'Hull's Deer Apple'	5.6
'Northwoods'	4.6
3.1 to 3.5 (1 1/4 to 1 3/8 inches)	
'Niska Gold'	3.1
2.6 to 3.0 (1 1/16 to 1 3/16 inches)	
'Gibbs Golden Gage'	3.0
'Niska Nugget'	2.8
robusta RO-33985	2.6
2.1 to 2.5 (13/16 to 1 inch)	
§ 'Almey'	2.5
robusta AA-22338-C	2.4
floribunda RO-3433	2.3
robusta AA-22665	2.3
§ 'Eleyi'	2.1
robusta persicifolia	2.1
1.6 to 2.0 (5/8 to 25/32 inch)	
§ 'Hopa'	2.0
robusta costata RO-3451	2.0
1.1 to 1.5 (7/16 to 19/32 inch)	
'Ellwangeriana' RO-271	1.5
§ 'Profusion' AA-338-50	1.5
toringoides AA-177-37-D	1.5
baccata jacki RO-902	1.3
baccata mandshurica RO-4051	1.3
'Bob White' AA-20367	1.3
'Winter Gold' DB-6	1.3
'Donald Wyman' AA-23029-B	1.3
hupehensis AA-17448	1.2
hupehensis RO-811	1.2
hupehensis P.O-843	1.2
1.0 or smaller (3/8 inch or smaller)	
baccata RO-808	1.0
Ormiston Roy DB-4	1.0
sargenti RO-734-A	1.0
sargenti RO-925	1.0
sargenti B.H.S. #2	1.0
zumi calocarpa RO-576	1.0
sieboldi	0.8

*From actual measurements or from Wyman (1955).

§Indicates clones with pink, carmine or red flowers, generally obtainable from commercial nurseries.

Table 2 lists the crab apple clones selected because of their fruit persistence and consistent use for food by wildlife, and recommended for use in grafting, or for planting where protection against deer, rabbits, woodchucks and mice can be provided. Fruit diameters were measured in September 1967 or were obtained from Wyman (1955).

Table 3 shows trees with persistent fruit, seen in Jamaica Plain, Rochester or ornamental plantings, for which insufficient records are available to judge use of the fruits by wildlife. Plants indicated with an asterisk have carmine, red or bright pink flowers, often double, so that they have considerable ornamental value.

Persistence of fruit on the branches of the crab apples was found to vary from species to species and, in the case of plants of hybrid seedling origin, from individual to individual, so that vegetative progagation was necessary to perpetuate fruit persistence. No individuals among the commercial class of apples (fruit 2½ inches in diameter or larger) were found that consistently held their fruit beyond November, so they are omitted from the listing.

Fruit persistence was found to be related to size and weight (e.g., the commercial apple clones), to the time the pomes were ripe, to the time the fruit became soft from ripeness as well as from freezing and thawing, and to the use of the fruit for food by wildlife. In general, fruit that ripened early and softened early in the autumn was the first to drop, as *Pyrus purpurea* (the purple crab) of hybrid origin which normally was bare of fruit by early December. The great majority of the crab apples

TABLE 3. CRAB APPLE CLONES WITH PERSISTENT FRUIT, BUT INSUFFICIENTLY TESTED FOR WILDLIFE USE, GROUPED ACCORDING TO DIAMETER OF FRUIT

Diameter group (centimeters)	Average diameter (centimeters)
3.1 to 3.5 (1 1/4 to 1 3/8)	
§ 'Redfield'	3.5
2.6 to 3.0 (1 1/16 to 1 3/16 inches)	
§ 'Sissipuk'	2.6
2.1 to 2.5 (13/16 to 1 inch)	
§ 'Sundog'	2.5
§ 'Crimson Brilliant'	2.2
§ Oakes DB-3	2.2
1.6 to 2.0 (5/8 to 25/32 inch)	
§ 'Selkirk' (Morden 457)	2.0
§ 'Van Eseltine'	2.0
1.1 to 1.5 (7/16 to 19/32 inch)	
§ 'Adams' AA-873-50	1.5
§ 'Dorothea' AA-70-44-F	1.5
§ 'Liset' DB-2	1.5

§Indicates clones with pink, carmine or red flowers, generally obtainable from commercial nurseries.

had fruit well softened by December. Several firm-fruited clones ('Profusion', 'Donald Wyman', 'Ellwangeriana' and 'Sissipuk') had persistent fruit in good color until March when the pomes started to soften and fall.

Each year, the crop of fruit on each grafted tree was rated as good, fair, poor or none produced, because of wide variations in tree size, age and vigor. In November 1970, a single, vigorous tree of 'Donald Wyman', from a 1959 graft and about 15 feet tall with a spread of 18 feet, produced 43,486 grams (95.87 pounds) of fruit. When 20 lots of 100 pomes each were weighed, the mean weight per hundred pomes was 103.16 grams, or 1.03 grams per pome. The calculated number of pomes picked was 42,151.

A vigorous 1959 graft of 'Niska Nugget', which had attained approximately the same dimensions by 1970, yielded 8,338 pomes (counted). Weighing 20 lots of 100 pomes each gave a mean weight of 596.75 grams per hundred pomes, or 5.97 grams per pome. The calculated weight of all the pomes was 49,757 grams or 109.69 pounds.

Removal of fruit by wildlife was fairly consistent, but depended on the wildlife species present, the relative abundance of wildlife foods and the severity of the winter season. Fruit that softened early in the fall and dropped to the ground was the first to be used, but it also was the first to be rendered unavailable by a snow cover. Generally, the hard-fruited clones were the most persistent and the latest to be used for food, but in one season on the Partridge Run area pine grosbeaks and evening grosbeaks were removing the hard pomes of the clone 'Profusion' by the last of November, crushing them and extracting the seeds. Table 1 shows the usual period of fruit retention for the various clones observed.

Wintering birds and gray squirrels fed on the small pomes while they were still on the trees. On the Partridge Run area the clone 'Winter Gold' was regularly used by ruffed grouse, which started feeding on the pomes in late October and continued until all were removed. The ability of this clone to retain its fruit was recorded at the Arnold Arboretum where in several seasons much of the fruit persisted unused until late winter.

Fruit that fell on bare ground or onto a snow cover was used for food by deer, cottontail rabbits, squirrels, ruffed grouse, pheasants and other wintering birds that would drop to the ground to feed. Deer stood up to pull the pomes off the branches they could reach. In the Arnold Arboretum, ringneck pheasants were observed on several occasions in January and February perched in the shrubby Sargent crabs eating the pomes. The slow but steady loss of pomes onto the snow or ground over a period of several months provided a steady supply of food for the ground-feeding species.

Following are brief descriptions of the flowers, fruit, fruit persistence and observed wildlife use of some of the crab apple clones that were

under consideration for planting or grafting to provide winter food for wildlife. All are persistent-fruited. They are grouped according to: (1) those recommended but seldom available from commercial sources; (2) those recommended and available from commercial sources; (3) those for which present information on use by wildlife is insufficient; and (4) those not recommended.

Ultimate heights to be expected are given, so that provision can be made for adequate growing space. Trees up to 20 feet in height are described as small; those from 20 to 30 feet are listed as medium-sized trees; those over 30 feet high are classed as large trees (for apples).

In general, where damage from deer, mice, cottontail rabbits and woodchucks would be a problem, the crab apple clones should be established only by top-working scion wood onto young, vigorously growing, volunteer apple trees such as are abundant in the abandoned pastures of the State. Such trees are on already established root systems and usually have rough bark that is not normally attacked by the gnawers. For lawn plantings where animal damage is not a problem, budded trees may be obtained from commercial nurseries. All the recommended clones are very hardy (to –20° F. or colder) so they may be used wherever volunteer apples will grow in New York, even in the central Adirondacks.

With few exceptions, as noted, these crab apples bear good crops of fruit annually. Even in a poor pollination year like 1968, when little fruit of any kind was produced, they produced fair crops of pomes which were rapidly consumed.

Persistent-fruited Crab Apples Recommended for Wildlife Food But Seldom Available From Commercial Sources

The crab apples in this group are of demonstrated wildlife value. They may be obtained as scion wood for grafting from existing trees, but they are seldom available as plants from commercial nurseries.

baccata (RO-808, RO-825) Siberian crab

These two very similar clones form trees up to 9 meters (30 feet) in height. Flowers are white, single and fragrant. Pomes are small, red and about 1 centimeter (3/8 inch) in diameter, with a deciduous calyx. The fruit normally persists until March or until used by wintering small birds.

baccata jacki (RO-902, RO-904) jack crab

These two trees grow to 9 meters (30 feet) in height. Flowers are white, single and fragrant. Pomes are about 1.3 centimeters (1/2 inch) in diameter and glossy dark red with a deciduous calyx. The pomes are usually hard until January after which, at Rochester, robins, grosbeaks and waxwings started to remove them. On the Partridge Run area,

grosbeaks and squirrels have removed the pomes while they were still hard.

baccata mandshurica (RO-4051) Manchurian crab

This grows to 9 meters (30 feet) in height. Flowers are white and single, with a deciduous calyx. Pomes are bright red, 1.2 centimeters (7/16 inch) in diameter and persist until mid-February or until removed. At Rochester the pomes were taken by pheasants, squirrels and small birds. On the Partridge Run area use was by wintering birds, grouse, deer, squirrels and cottontail rabbits.

'Bob White' (AA-20367, RO-4053)

This grows to 6 meters (20 feet) in height. Flowers are pink in bud, opening white, with a deciduous calyx. Pomes are 1.0 to 1.5 centimeters (3/8 to 1/2 inch) in diameter and pale yellow to dull brown in color. These will persist until April, but normally they are removed by March. This clone was named many years ago because bob-white quail took the pomes. At the Arnold Arboretum, grouse, pheasants, squirrels and wintering birds have also been observed eating the fruit. A young gray squirrel, reared in captivity, given a handful of the pomes, promptly bit away and discarded the pulp to get at the seeds. The larger birds swallow the pomes whole, but the small birds pick out the seeds after the pulp is soft. Old trees bear so heavily that fruiting is good in alternate years, but young trees and those produced by top-working onto volunteer apple trees have been annual bearers. This clone is one of the few in this group that is available from commercial nurseries.

'Donald Wyman' (AA-23029-B)

The ultimate size of this tree is up to 6 meters (20 feet). Flowers are white and single, with a deciduous calyx. Pomes are 1.3 centimeters (1/2 inch) in diameter and bright, glossy red in color. The pomes persist, if untouched, in good color until April and may remain until new foliage and flowers emerge in May. At the Arnold Arboretum and at Delmar the hard pomes were unused until late March and early April, when robins, waxwings and starlings were observed swallowing them whole. On the Partridge Run area, pine grosbeaks and evening grosbeaks were able to break down the hard pomes in early December. In 1968, a very poor fruiting season, this clone fruited fairly well. All trees there were stripped of fruit by mid-December, when almost no other fruit was available. This clone was named in 1970 after the former horticulturist at the Arnold Arboretum, who compiled much of the information available about the crab apples.

'Ellwangeriana' (RO-271)

This clone grows to an ultimate height of 6 meters (20 feet). Flowers

are pink and white, and single, with a deciduous calyx. Pomes are bright red and 1.6 centimeters (5/8 inch) in diameter. They retain their bright color and firm texture all winter, or until removed, so that this clone is of value in extending the season of availability after the fruit of other crab apples has been consumed.

floribunda (RO-3433) Japanese flowering crab

This makes a larger tree, to 9 meters (30 feet) in height. Flowers are pink and white, and single, with a persistent calyx. Pomes are about 2.4 centimeters (15/16 inch) in diameter and greenish yellow with a dull red blush on one side. They persist until spring or until used. This tree was first noted by the writer in 1955 in Highland Park, Rochester, because pheasants, squirrels and cottontail rabbits were leaving a maze of tracks under it as they consumed the fruit. Grafted trees on the Partridge Run area have been furnishing good crops of food for deer, raccoons, squirrels, cottontails and wintering birds.

'Gibb's Golden Gage' (DB-1)

This tree grows to about 7 meters (24 feet) in height. Flowers are pink in bud, opening white, and single. Pomes are 2.5 centimeters (1 inch) in diameter and pale yellow, with a persistent calyx. They persist if undisturbed until February and March. Squirrels and wintering birds use the fruit.

'Hull's Deer Apple'

This selection from the common apple probably makes a large tree up to 12 meters (40 feet) tall. Flowers are white and single. Pomes are almost in the commercial apple class being 5.6 centimeters (2 3/16 inches) in diameter and are green with faint red vertical striping at the stem end, with a persistent calyx. The pomes, though frozen, have persisted until March when undisturbed. As the name indicates, the pomes are used by deer as well as by birds, squirrels and cottontails. Like other clones of the common apple, after grafting it grows vigorously but vegetatively for 4 or 5 years before it starts to flower and fruit. Like the common apple forms, its leaves and fruit are susceptible to apple scab.

hupehensis (AA-17448, RO-811, RO-832, RO-843, RO-3449) tea crab

The tea crab makes a medium-sized tree up to 7 meters (24 feet) in height. Flowers are pink in bud, opening white, and single, with a deciduous calyx. Pomes are about 1.2 centimeters (7/16 inch) in diameter and greenish yellow in color. The fruit softens by December or early January, but it persists well to mid-February if not removed. Normally, wintering robins, waxwings and other birds have removed all fruit by mid-January. At Partridge Run grouse have been observed taking the pomes from grafted trees. Large old trees at Rochester and Jamaica

Plain fruited heavily in alternate years, but grafted trees have fruited less abundantly, but annually, at Partridge Run.

'Niska Gold'

The original tree, resembling a commercial crab apple, was about 9 meters (30 feet) high. Flowers are white and single, with a persistent calyx. Pomes are 3.1 centimeters (1 3/16 inches) in diameter and pale yellow with a faint yellow-pink blush on one side. The pomes persist until March if undisturbed. This tree was first noted in 1950 because deer, grouse, pheasants, squirrels and cottontails were all using the fruit. Grafted trees at Partridge Run have continued to attract all these species except the pheasant, which is absent. Deer pull down the branches to get the pomes. Raccoons have caused some damage in climbing out onto the branches to get the fruit.

'Niska Nugget'

Resembling a commercial crab apple, this tree will reach a height of 9 meters (30 feet). Flowers are white and single, with a persistent calyx. Pomes are 2.8 centimeters (1 1/4 inches) in diameter, wider than tall and have a pale orange color with light red vertical striping. They persist when unused until late March. This, like the preceding clone, was first noticed in a pasture during the winter of 1949-50 when a maze of tracks of deer, cottontails, grouse, pheasants and squirrels showed a high degree of wildlife use of the pomes until all were consumed. Similar use was observed for the next five years. In 1956 and 1957 the first scions were taken and used to top-work volunteer apple trees on the Partridge Run game management area. These first flowered and developed fruit in 1960, after which wildlife use was repeated annually. On deep snows deer have pulled the fruit from the branches, and grouse, squirrels and wintering small birds have extracted the seeds from the softened fruit.

'Northwoods'

This is a clone of the common apple, probably making a large tree up to 12 meters (40 feet) tall. Flowers are white and single, with a persistent calyx. Pomes are 4.6 centimeters (1 3/16 inches) in diameter, somewhat longer than broad and pale yellow with a slight pale red blush and yellow-white flesh. These are eagerly sought by deer, that have stood on their hind legs to pull down the pomes. Otherwise, fruit persists until mid-February. The original tree was noted as having persistent fruit used by wildlife in the Adirondacks, hence the name which has been applied.

robusta (AA-22338-C) cherry crab

This hybrid (*Pyrus baccata* x *P. prunifolia*) makes a large tree up to 12 meters (40 feet) high. Flowers are white and single, with a

persistent calyx. Pomes are cherry red over a yellow background and 2.4 centimeters (15/16 inch) in diameter. They persist until March, though frozen and brown, unless removed. Wintering birds pick out the seeds, and deer and cottontail rabbits use the fallen fruit. This makes a vigorous growing tree with stout thorn-like spurs.

robusta (AA-22665) cherry crab

This makes a large tree up to 12 meters (40 feet) tall. Flowers are white and single, with a persistent calyx. Pomes are greenish yellow with a red blush on one side and 2.3 centimeters (7/8 inch) in diameter. The fruit is usually frozen by late December, but persists until February or even to late March. At the Arnold Arboretum gray squirrels climbed for the fruit, while fallen fruit was eaten by cottontail rabbits. On the Partridge Run area where trees were top-worked to this clone, the pomes were taken by deer, raccoons, squirrels, cottontails and wintering birds. Although listed at the Arnold Arboretum as an alternate-year producer, it has fruited well annually at Partridge Run.

robusta (RO-33985) cherry crab

This clone of the cherry crab makes a medium-sized tree up to 9 meters (30 feet) in height. Flowers are white and single, with a persistent calyx. Pomes are light yellow with a red-striped blush over one-third to one-half the surface and 2.5 centimeters (1 inch) in diameter. Fruiting was good on the grafted trees at the Partridge Run area from 1960 until 1968 when the crop was poor. At Rochester the original tree had two poor crop years between 1957 and 1970, following heavy crops the previous season. Pomes persist well until March, unless previously removed by wildlife. At Rochester, after a January glaze storm had pulled branches to the ground, a deer bedded down under the shelter for some days and fed on the fruit. On the Partridge Run area, deer have pulled down the branches to reach the fruit, while squirrels, grouse, raccoons and wintering birds have removed the fruit from the branches, and deer and cottontails have salvaged the fallen pomes.

robusta costata (RO-3451) cherry crab

This clone makes a fairly large tree, to 9 meters (30 feet) in height. Flowers are pink in bud, opening white, and single, with a persistent calyx. Pomes are orange with a red vertically striped overwash and about 2 centimeters (3/4 inch) in diameter. The fruit persists until March, and is used by deer, squirrels, cottontail rabbits and wintering birds.

robusta persicifolia (DB-5) cherry crab

This is a fairly large tree, to 9 meters (30 feet) high. Flowers are white and single. Pomes are bright red with a yellow background and about 2.1 centimeters (13/16 inch) in diameter, with a persistent calyx. The fruit

persists until late February or March unless removed. Deer, squirrels, cottontails and wintering birds have used the fruit.

sargenti (RO-925) Sargent crab

This is a low dense bush, rather than a tree, about 2.4 meters (8 feet) in height. Flowers are white and single, with a deciduous calyx. Pomes are red and about 1 centimeter (3/8 inch) in diameter. They soften as early as October but persist if undisturbed until February and March. Old plants tend to fruit heavily in alternate years, but younger top-worked plants have fruited well annually. The pomes are used by pheasants, squirrels and wintering birds. Plants of this bush type, set out on the Connecticut Hill Management Area about 1940 by the U.S. Soil Conservation Service have fruited well annually. Planted on thin, heavy glacial till soils, they have been heaved by frost action and have shown a tendency to send up sprouts from the exposed roots. Such plants, on their own roots, are thus able to survive occasional girdling by mice and rabbits and to spread slowly.

sargenti (RO-734-A) Sargent crab

This is a taller form of the Sargent crab, up to about 3 meters (10 feet) high. Flowers are white and single, with a deciduous calyx. Pomes are red and about 1 centimeter (3/8 inch) in diameter. They soften as early as October but persist until February and March or until removed by pheasants, squirrels and wintering birds. At the Arnold Arboretum, on several occasions in January, pheasants were observed perched in old, tree-like forms of this type, feeding in the pomes.

sargenti, Slavin #2 (tall form) Sargent crab

This selection from the Sargent crab is even taller than the preceding form, up to about 3.5 meters (12 feet) in height. Flowers are white and single, with a deciduous calyx. Pomes are red and about 1 centimeter (3/8 inch) in diameter. They soften as early as October but persist if undisturbed until February and March. Wintering birds and squirrels were observed removing the fruit from the original tree at Rochester, and later from grafted plants on the Partridge Run area.

sieboldi (RO-3436) Toringo crab

This makes a small tree up to 4 meters (14 feet) in height. Flowers are white and single, with a deciduous calyx. Pomes are yellow, or red in some forms, and 1 centimeter (3/8 inch) in diameter. They soften in November and December but persist if undisturbed until March. Wintering birds and squirrels remove the small fruit or pick out the seeds. Since the 1940's a dense clump of these trees has provided seed for 25,000 to 50,000 seedlings in most years. These have been distributed for wildlife plantings through the county soil conservation districts and

through the Department's regional wildlife management offices. Because of injuries to such seedlings by mice, rabbits, woodchucks and deer, however, it is recommended that this and other selections from the Toringo crab be top-worked onto volunteer apple trees, whose rough bark is less attractive to gnawing and chewing animals.

toringoides (AA-177-37-D) cutleaf crab

The cutleaf crab makes a tree up to 7.6 meters (25 feet) tall. Flowers are white and single, with a deciduous calyx. Pomes are yellow with a red wash on the sun side and 1.5 centimeters (5/8 inch) in diameter. They persist until late February or early March if undisturbed. Wintering birds and squirrels use the fruit.

'Winter Gold' (DB-6)

This makes a small tree up to 6 meters (20 feet) in height. Flowers are pink in bud, opening white, and single, with a calyx that may be either persistent or deciduous. Pomes are yellow and 1.3 centimeters (1/2 inch) in diameter. They persist until February and March if undisturbed. The fruit is used by wintering birds and squirrels. Between 1963 and 1969, on the Partridge Run area, ruffed grouse took the fruit off one grafted tree, beginning each year in November and continuing until all were gone by early December. One year, a poacher put his peculiar stamp of approval on this selection by shooting a feeding grouse out of the tree despite the fact that the tree was well within a refuge.

zumi calocarpa (RO-576)

This makes a small tree up to 6 meters (20 feet) in height. Flowers are pink in bud, opening white, and single, with a deciduous calyx. Pomes are bright red and 1 centimeter (3/8 inch) in diameter. They soften in November but persist until February or March when undisturbed. Migrating and wintering birds remove the fruit between November and February.

Persistent-fruited Crab Apples Recommended for Wildlife Food and Available From Commercial Sources

The crab apples in this group are of demonstrated wildlife value. Also, they have pink, carmine or red flowers, and hence are of ornamental value. They are usually available from commercial nurseries specializing in the so-called flowering or ornamental crab apples.

'Almey'

This tree reaches 9 meters (30 feet) in height and has single, carmine flowers that fade to pink. Pomes are orange-red to bright red and 2.5 centimeters (1 inch) in diameter, with a persistent calyx. The fruit

usually persists until February and is used by squirrels and wintering birds.

'Dorothea'

This tree reaches 7.6 meters (25 feet) in height and has semi-double, pink and white flowers. Pomes are yellow and 1.5 centimeters (9/16 inch) in diameter with a persistent calyx. They persist until March and April. Wintering birds make use of the fruit in late winter in ornamental plantings.

'Eleyi'

This small tree reaches 6 meters (20 feet) in height and has single, purplish red flowers. Pomes are red-purple and 1.5 to 2.5 centimeters (9/16 to 1 inch) in diameter. They persist until March. Fruiting in old plantings has been erratic. On the Partridge Run area, deer pulled the pomes from the reachable branches and dug through the snow for those that had fallen.

'Hopa'

This tree reaches 9 meters (30 feet) in height and has single flowers opening carmine and fading to dull pink. Pomes are bright red and 2 centimeters (3/4 inch) in diameter, with a persistent calyx. The fruit is persistent until March. Squirrels and wintering birds have been observed extracting the seeds from ornamental plantings.

'Ormiston Roy'

This small tree reaches 6 meters (20 feet) in height and has single, pink flowers. Pomes are pale yellow and 1 centimeter (3/8 inch) in diameter, with a deciduous calyx. They persist when undisturbed until March. Squirrels and wintering birds extract the seeds in ornamental plantings.

'Profusion'

This small tree reaches 6 meters (20 feet) in height and has single carmine flowers, with a deciduous calyx. Pomes are bright red and 1.5 centimeters (9/16 inch) in diameter. They persist until they soften in March and April, when robins, waxwings and starlings remove the pomes by swallowing them whole. On the Partridge Run area, in November and December of 1968, pine grosbeaks and evening grosbeaks easily crushed the firm pomes and extracted the seeds.

Persistent-fruited Crab Apples for Which Information In Wildlife Use Insufficient

The crab apples in this group, with colored flowers and persistent fruit, have not been observed long enough to determine the value of the

pomes as food for wildlife. They are generally available from nurseries specializing in ornamental crab apples.

'Adams' (AA-873-50)

This has been observed as a small tree 6 meters (20 feet) in height, with single deep pink flowers and persistent calyx. Pomes are dark red, 1.5 centimeters (9/16 inch) in diameter and persist until late March. Wildlife use of the pomes was not observed, though they did fall and ultimately disappear. Sudden death of apparently healthy scions top-worked onto a volunteer apple tree suggested the presence of a virus infection, but successful grafts onto other trees indicated the fault lay in the understock tree used in the former case.

'Crimson Brilliant'

This has been observed as a small tree up to 6 meters (20 feet) in height, with single or semi-double purplish-red flowers. Pomes are purplish-red, with a persistent calyx and 2.2 centimeters (7/8 inch) in diameter. They persist until March. Purchased plants have not been exposed to wildlife long enough to learn what species use the pomes for food.

'Liset'

This has been observed as a small tree up to 6 meters (20 feet) in height, with purplish-red flowers and persistent calyx. Pomes are red and 1.5 centimeters (9/16 inch) in diameter. They persist until late February or early March. This has not been exposed sufficiently to determine wildlife use of the fruit.

'Oakes'

This has been observed as a small tree up to 6 meters (20 feet) in height, with single purplish-red flowers and persistent calyx. Pomes are bright red and 2.2 centimeters (7/8 inch) in diameter. They tend to go soft by November but persist until March or even early April. Grafted plants have not fruited often or long enough for observations on wildlife use.

'Sissipuk'

This small to medium-sized tree, to 9 meters (30 feet) in height, bears single purplish-red flowers. Pomes are dark maroon or purplish-red and 2.6 centimeters (1 inch) in diameter, with a persistent calyx. The fruit remains firm and persists until late March and early April.

spectabilis riversi (RO-3429) Rivers crab

This makes a large tree up to 12 meters (40 feet) in height, with double pink flowers. Pomes are yellow and 2.5 centimeters (1 inch) in diameter, with a persistent calyx. They persist until February and

March. Pheasants and wintering birds used the fruit at Rochester. Grafted plants at Partridge Run have not fruited sufficiently for wildlife use to be observed.

'Selkirk' (formerly Morden #457)

This has been observed as a small tree up to 6 meters (20 feet) in height, with single pink flowers. Pomes are red and 2.0 centimeters (¾ inch) in diameter, with a persistent calyx. The pomes persist until March, but purchased plants and grafted trees have not fruited sufficiently for observations on wildlife use.

'Van Eseltine'

This has been observed as a tree up to 7 meters (24 feet) in height, with double pink and white flowers. Pomes are red and yellow and 2.0 centimeters (¾ inch) in diameter, with a persistent calyx. The fruit is persistent until March. Wildlife use is as yet unknown.

PERSISTENT-FRUITED CRAB APPLES NOT RECOMMENDED

The following clones have persistent fruit, but they bear well only in alternate years or have grown poorly when grafted. Therefore, they are not recommended for use as food for wildlife.

dawsoniana (RO-3461, RO-3491)

These two trees reach 11 meters (35 feet) in height and bear single white flowers. The elongated pomes are 2.5 centimeters (1 inch) wide by 4 centimeters (1 9/16 inches) long and yellow green with vertical red streaking, with a persistent calyx. At Rochester, the pomes persist until February and March and are used by pheasants, squirrels and cottontail rabbits. Growth of grafted trees has been slow, with poor fruit production, so that wildlife use has not been observable.

'Katherine' (RO-966)

This small tree reaches 6 meters (20 feet) in height and bears double pink and white flowers. Pomes are yellow, with a deciduous calyx, and 1 centimeter (⅜ inch) in diameter. They persist until February and are used by wintering birds. Because the trees tend to bear at all only in alternate years, this clone is not being used.

DISCUSSION

As yet no concrete evidence can be presented that the establishment of crab apples producing large annual crops of fruit will do more than augment the existing food supply for wildlife or attract wildlife to places where it may be seen. There can be no question that making some food available where there was none before will change the distribution of the wildlife species that use it. What needs to be demon-

strated is whether an augmented winter food supply can increase the carrying capacity of an area for a given wildlife species.

A considerable variety of clones has been recommended for use in providing winter wildlife food, so as to provide a wide range in fruit size, shape, degree of firmness and degree of persistence, as well as in the size of the tree. Use of these clones will vary, from that of an individual desiring to attract wildlife but with room for only one or two trees, to that of a landowner wishing to improve hunting opportunities or to attract wildlife on a hundred-acre property, to that of the wildlife manager responsible for maintaining or trying to increase the carrying capacity of several thousand acres of wildlife management lands.

The budded trees obtainable from commercial nurseries are suitable for the home lawn, shrub border or garden where cultivation or close mowing discourages the mice, rabbits and woodchucks that could damage or destroy them. If these animals, or deer, will be a hazard, then the usual precautions must be taken: hardware cloth or roofing paper guards on the trunks or deer-proof fencing.

The planting of budded trees in the poorly-drained, infertile, hilltop soils on abandoned farmland, such as the Lordstown, Volusia, Mardin and Arnot soils of the Southern Tier, cannot be recommended. Unless these trees are planted in well-drained, fertile soil, they will grow poorly and be susceptible to attacks by the flat-headed borers which girdle them at their bases. Mice, rabbits and woodchucks are all attracted to the smooth trunks of such young trees, and hardware cloth trunk guards are a necessity. Nevertheless, the normal depths of snow make it difficult to protect the trees from mice and rabbits which can destroy a tree in a single winter. Browsing on foliage and twigs by deer further reduces the chances of survival of budded trees.

Where the vegetation cannot be removed to bare ground, or kept closely mowed as on a lawn, the practice of top-working scions onto young, already established volunteer apple trees, so abundant in old pastures, is recommended. Such trees have an already existing root system and usually have the rough scaly bark that discourages the gnawning animals. If the scions are top-worked at a height of 5 feet or more, they will normally be out of the reach of mice, rabbits, woodchucks and deer, unless snowdrifts make the grafts reachable.

For those clones which are not available commercially, scion-wood from existing trees must be used. Grafting, a relatively easy process to learn, is usually done in early spring just before the apple buds start to swell. This period varies considerably, from mid- to late March on Long Island, to mid-April for the central and western counties, to late April or early May for the northern counties.

The small-fruited crab apple clones, up to 1.5 centimeters in fruit diameter (see Table 2), are best adapted to providing winter food for

small birds, pheasants, ruffed grouse and squirrels. Pheasants, ruffed grouse, robins and waxwings have been observed swallowing fruit up to this size without apparent difficulty. Smaller birds pick out the seeds when the fruit has softened from ripening or from alternate freezing and thawing. Pine grosbeaks and evening grosbeaks have been observed crushing the hardest fruits ('Donald Wyman', 'Profusion') and apparently extracting only the seeds. They also have been observed working on the larger fruit of such clones as 'Almey' and 'Hopa'. Pheasants have been observed feeding on the fallen fruit of the larger-fruited clones, such as 'Niska Gold' and 'Niska Nugget'.

The larger-fruited clones, from 1.6 to 5.6 centimeters in fruit diameter, have furnished food for deer, raccoons, opossums and cottontail rabbits, that can handle this size easily, as well as for ruffed grouse, pheasants, and even the smaller birds, that can extract the seeds from softened fruit. Fruit on the lower, reachable branches, as well as that dropping from time to time, becomes available to the ground-feeding species.

The volume of fruit produced by each clone has not been measured, except in the two instances noted, since it varies according to the clone, the size, age and vigor of the tree, flower production and success of pollination. At the Painted Post nursery, seed of the Toringo crab (*Pyrus sieboldi*) is obtained from a group of seven plants so closely grown that they assume the appearance of a single tree. Some 60 to 80 pounds of fresh fruit have yielded 5 pounds of clean seed. Seed harvest from this clump of trees has varied from a high of 13 pounds to a low of 3 pounds, except in 1968, a poor year for pollination of any kind, when none was harvested.

The number of trees to be grafted will depend on the number and condition of volunteer apple trees available. The hills of the Southern Tier counties have many former hillside pastures full of volunteer apple trees, established after seed passage through livestock and well suppressed until the pasture was abandoned. Elsewhere, volunteer apple trees may be scarce, as in the Adirondacks, but even there trees can be found along roadsides and in clearings even in the forest areas.

Young, vigorously growing stems, up to 3 or 4 inches in diameter breast high, should be chosen for top-working. Reworking large, old orchard trees is not recommended.

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THE FISHES OF GARDINER'S ISLAND, NEW YORK[1]

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ABSTRACT

Gardiner's Island is a privately owned island whose ichthyofauna had not previously been surveyed by any agency. Furthermore, it includes a series of ponds which provide an opportunity for distinctly different fish populations to become established. This paper presents information concerning the fishes present and their distribution, together with data on the characteristics of the ponds.

The fish fauna of Long Island has been the object of several major studies, e.g., Bean (1901), Nichols and Breder (1926), Greeley (1939), Perlmutter (1939), Gordon (1951), Alperin and Schaefer (1965). None of these or any other studies had access to the privately owned and highly protected and restricted Gardiner's Island. This is the first report of the ichthyofauna on this 3,337-acre island which is located between the south and north forks of the eastern end of Long Island and bordered on the northeast by Block Island Sound and on the southwest by Gardiner's Bay.

In addition to the basic survey of species, an ecological analysis of the distinctive water area on the island was undertaken. The island includes several bodies of water that range from marine tidal ponds and creeks to those occasionally influenced by the influx of seawater to freshwater areas closed to the sea. A major interest was to what extent the ichthyofauna reflected this diversity of habitats.

METHODS AND MATERIALS

The fishes of the six major ponds and creeks located on the periphery of the island (Figure 1) were surveyed in 1971 between late July and early September. No fish were found in the small freshwater ponds and streams farther inland. Collections were made using ¼-inch-mesh 10-foot minnow seines and 100- to 150-foot beach seines. All of the major habitats within a particular body of water were sampled repeatedly. Sampling was terminated only after further efforts yielded no additional species. Information concerning the salinity (measured with a Beckman RS5-3 portable salinometer), temperature, depth, bottom type and predominant vegetation was recorded.

[1]The authors wish to acknowledge the assistance of Dr. Edward Hehre of Southampton College in identifying the aquatic vegetation and to thank Mr. Robert D. L. Gardiner for his permission to work on the island.

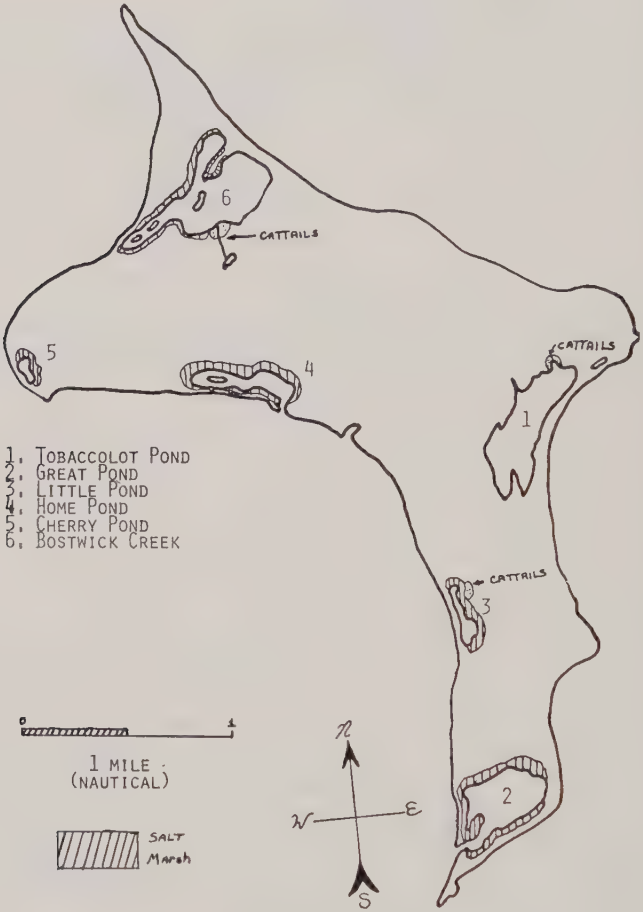

Figure 1. Map of Gardiner's Island showing location of ponds studied.

RESULTS

The various species of fish collected and their distribution among the water areas studied are given in Table 1. The data on salinity and temperature recorded for the six areas are summarized in Table 2 together with comparative values for Gardiner's Bay. Following are additional comments concerning pond characteristics.

Tobaccolot Pond

In the recent past this was a bay-influenced pond as a result of conduits, at the northeast corner, that were constructed between the pond and the bay. Natural forces have since closed off this pond to a greater

TABLE 1. DISTRIBUTION OF FISHES AMONG THE PONDS SURVEYED ON GARDINER'S ISLAND, 1971

Family and species	Tobaccolot Pond	Bostwick Creek	Little Pond	Cherry Pond	Home Pond	Great Pond
Anguillidae						
Anguilla rostrata (American eel)		X		X	X	X
Clupeidae						
Clupea harengus (Atlantic herring)						X
Brevoortia tyrannus (Atlantic menhaden)					X	X
Batrachoididae						
Opsanus tau (oyster toadfish)					X	X
Gadidae						
Microgadus tomcod (Atlantic tomcod)						X
Belonidae						
Strongylura marina (Atlantic needlefish)					X	X
Cyprinodontidae						
Cyprinodon variegatus (sheepshead minnow)		X	X	X	X	X
Lucania parva (rainwater killifish)		X	X	X	X	X
Fundulus heteroclitus (mummichog)	X	X	X	X	X	X
Fundulus majalis (striped killifish)	X	X	X	X	X	X
Fundulus diaphanus (banded killifish)	X					
Atherinidae						
Menidia menidia (Atlantic silverside)	X	X	X	X	X	X
Menidia beryllina (tidewater silverside) *						
Gasterosteidae						
Gasterosteus aculeatus (threespine stickleback)	X					
Apeltes quadracus (fourspine stickleback)	X	X	X	X	X	X
Syngnathidae						
Syngnathus fuscus (northern pipefish)					X	X
Triglidae						
Prionotus carolinus (northern sea robin)					X	
Percichthyidae						
Morone americana (white perch)	X	X				
Pomatomidae						
Pomatomus saltatrix (bluefish)						X
Carangidae						
Caranx hippos (crevalle jack)						X
Trachinotus falcatus (permit)					X	
Sciaenidae						
Menticirrhus saxatilis (northern kingfish)					X	
Mugilidae						
Mugil cephalus (striped mullet)					X	X
Labridae						
Tautoga onitis (tautog)					X	X
Tautogolabrus adspersus (cunner)						X
Ammodytidae						
Ammodytes americanus (American sand lance)					X	X
Tetraodontidae						
Sphoeroides maculatus (northern puffer)					X	X
Pleuronectidae						
Pseudopleuronectes americanus (winter flounder)						X
Number of species§	7	8	6	7	18	21

*Subsequently found among the silversides collected, but distribution not recorded.

§Total number of species: 28.

Table 2. Salinity and Temperature Data for the Ponds Surveyed on Gardiner's Island and for Gardiner's Bay, 1971

Water area	Salinity (ppt)	Temperature* (° C.)
Tobaccolot Pond		
North	4.2	23.8
Northeast	4.4	27.1
Southwest	4.5	26.8
Bostwick Creek		
East	10.8	28.5
West	6.0	30.4
Middle	6.8	30.4
Little Pond		
North	21.1	21.4
South	21.4	21.5
East	5.6	23.0
Cherry Pond		
North	28.3	21.9
South	28.1	24.4
West	28.9	21.9
Home Pond		
East	27.7	27.5
West	27.1	28.6
Middle	27.5	27.5
Great Pond		
Northeast	27.5	28.6
West	30.6	27.7
Middle	29.1	27.3
Gardiner's Bay	28.2	22.6

*Average for period August 2 - September 3.

degree than any of the other ponds. Sand, mud and stone constitute the bottom. The depth is variable, reaching a maximum of about 6 feet at the center. There was no significant salt-marsh vegetation; instead a freshwater flora predominated (*e.g., Potamogeton* and *Typha*).

Bostwick Creek

Although seawater may enter at the eastern end during severe storms, freshwater feeder streams and springs at the western end contribute in maintaining relatively low salinity. A predominantly sandy and muddy bottom with extensive areas of shallow water occurs at the western end. Aquatic vegetation became sparser and the water deepened toward the eastern end, with only modest salt-marsh development.

Little Pond

This relatively shallow pond possessed the widest range of salinities and associated vegetation (from cattails to salt marsh). The cattails flourished at the northeastern end as a result of a freshwater-spring influence. The bottom consists of sand and mud.

CHERRY POND

Salinity values and field observations suggest that, although it appears physically isolated from the bay, this pond does receive seawater seepage. It is relatively shallow with a muddy bottom. Salt-marsh vegetation was evident together with an extensive algal mat (*Cladophora*) that covered approximately 10 per cent of the surface at the northwestern end.

HOME POND

A short and narrow inlet, bulkheaded on one side, contributes to the bay's influence on this pond at its eastern end. The deeper backwaters possess a muddy bottom and were bordered by typical salt-marsh plants (*Spartina, Distichlis, Salicornia, Pluchea, Gerardia, Juncus*).

GREAT POND

The extensive inlet provides a significant tidal influence on the entire pond. The bottom generally consists of a firmer substrate than is found in any of the other ponds. In addition to an extensive salt marsh, there was an abundance of marine life. Most noticeable, in the early fall, was the large population of the blueclaw crab (*Callinectes sapidus*).

The most evident conclusions to be drawn from these data are that: (1) Home Pond and Great Pond contained a greater number of fish species than the other, more restricted ponds; (2) some species had a highly restricted distribution while others occurred in all the waters studied; (3) the waters studied represented a broad range of aquatic environments.

DISCUSSION

Many of the ponds (Tobaccolot, Bostwick, Little and Cherry) show evidence of having been open and closed to bay waters to varying extents in the past. Maps dated 1903 (U.S.G.S.) and 1951 (U.S.C.&G.S 362) confirm this by differing from one another as well as from present conditions. Whether or not a particular pond is currently fresh or saline appears to depend on the occurrence and severity of storms in the area.

Owing to the limited duration of field work, all of the fish species that occur on Gardiner's Island throughout the year were not recorded. It is likely that the fish population of those waters relatively open to the sea (Home Pond and Great Pond) changes somewhat seasonally. But, because the narrow inlets to these ponds may act as filters, there is no reason to suspect the existence of a significantly more diverse population than that recorded during this study. It is probable that the fishes found in the other waters are more representative of the year-around populations there.

Moreover, the differences in species composition found among the waters studied appears to be a valid reflection of habitat differences. The topography and salinity of Home Pond and Great Pond provide ready access to fish from the surrounding bay waters, and three times as many species were found there as in the other ponds.

The mummichog, striped killifish, silverside and fourspine stickleback, being highly euryhaline, were found in all the environments. The banded killifish and white perch were restricted to freshwater conditions, whereas 17 other species were restricted to highly saline waters.

The five cyprinodontids exemplify the influence salinity has on the distribution of a diverse fish family. Most noteworthy is that the banded killifish (*Fundulus diaphanus*) appears to occupy the niche in the freshwater Tobaccolot Pond that is assumed by the euryhaline sheepshead minnow (*Cyprinodon variegatus*) and the rainwater killifish (*Lucania parva*) in the other ponds.

Among the sticklebacks, *Gasterosteus aculeatus,* in contrast to *Apeltes quadracus,* was found only in the freshwater habitat. This is consistent with known salinity tolerances within the family (Nelson, 1968) and with their requirements for breeding.

The carangids are relatively uncommon to these waters (Alperin and Schaefer, 1965) and may be included in that group of expatriate fishes that occur as juveniles during the late summer and early fall along the south shore of Long Island. However, few such fish were observed in the ponds on Gardiner's Island. The south fork of Long Island apparently acts as a moderate barrier against their movement into the area. Furthermore, the inlets of the available ponds all occur on the western side of the island, i.e., opposite to the side that would likely be exposed to these fishes if they were swept by ocean currents toward Gardiner's Island.

No species of fish was found on Gardiner's Island that does not occur elsewhere in the Long Island area. However, in the absence of the impact of man's activities on the island, a uniquely well-balanced and nearly pollution-free environment has existed. This has not only provided a sanctuary for the juveniles of many fish species but has also promoted a diverse and large fish population which in turn supports other aspects of the island's ecology.

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DEER LOSSES IN THE PERIPHERAL ADIRONDACKS

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ABSTRACT

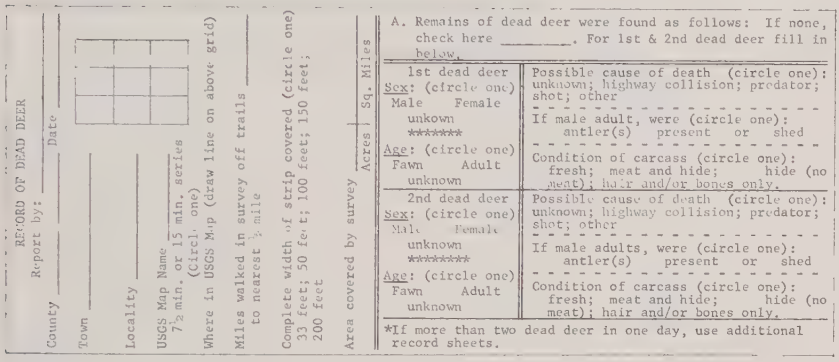
The failure of deer populations to increase in the peripheral Adirondacks has been noted for some 50 years. To obtain information on the losses occurring, arrangements were made in 1965-66 and 1966-67 for field crews of the Bureau of Forest Pest Control to report all dead deer found in their surveys which represented 100 per cent coverage of specific tracts. From these records, the corresponding losses for the region as a whole were calculated. These figures were compared with the estimated deer population of the region and the total losses among fawns and adult females that must have been taking place to prevent an increase. Only 34 per cent of such losses was accounted for. Apparently, unknown losses were the paramount limiting factor. Where there was a legal harvest of antlerless deer, the data indicated that this took the place of certain of the unknown losses otherwise occurring.

The failure of deer populations to increase in the peripheral Adirondacks and certain other areas of New York has been noted for some 50 years. Small, widely dispersed populations in these areas that provide a harvest of one buck for 2 to 25 square miles of deer range have been characteristic (Severinghaus, 1958; Severinghaus and Free, 1963). To document the existence of losses and assess their role as a factor in limiting population growth has been a problem. A means was needed of obtaining sufficient data concerning deer mortality to be meaningful.

The Bureau of Forest Pest Control of the Division of Lands and Forests of the Department of Environmental Conservation annually surveys tens of thousands of acres of forest land to determine the occurrence, distribution and intensity of insect and disease problems. Field work involves 100 per cent inspection of certain areas in assigned locations scattered throughout the State and normally runs from September to May each year. The personnel making these surveys walk prescribed lines and the areas covered can be determined. These lines are off trails and are not necessarily oriented to any specific land use. These conditions created the possibility that in their surveys such personnel, in addition to forest pest information, could also record information on dead deer found. The field crews are accustomed to recording details, and the additional record keeping would be small. With dead deer found on these surveys systematically reported, it might be possible to use the data to estimate deer losses over contiguous, similar range.

Arrangements were made for a trial of the method from September 1965 to May 1967. Records were kept by all forest pest control field crews for all survey work throughout the State. Data recorded included

the date, location and area surveyed, together with the sex, age, condition and possible cause of death of any dead deer found. The field form used is illustrated in Figure 1.



RECORD OF DEAD DEER

Report by: _____ Date _____

County _____

Town _____

Locality _____

USGS Map Name _____ 7½ min. or 15 min. series (Circle one)

Where in USGS Map (draw line on above grid)

Miles walked in survey off trails _____ to nearest ½ mile

Complete width of strip covered (circle one) 33 feet; 50 feet; 100 feet; 150 feet; 200 feet

Area covered by survey _____ Acres / Sq. Miles

A. Remains of dead deer were found as follows: If none, check here _____. For 1st & 2nd dead deer fill in below.

1st dead deer	
Sex: (circle one) Male Female unkown *******	Possible cause of death (circle one): unknown; highway collision; predator; shot; other
	If male adult, were (circle one): antler(s) present or shed
Age: (circle one) Fawn Adult unknown	Condition of carcass (circle one): fresh; meat and hide; hide (no meat); hair and/or bones only.
2nd dead deer	
Sex: (circle one) Male Female unknown *******	Possible cause of death (circle one): unknown; highway collision; predator; shot; other
	If male adults, were (circle one): antler(s) present or shed
Age: (circle one) Fawn Adult unknown	Condition of carcass (circle one): fresh; meat and hide; hide (no meat); hair and/or bones only.

*If more than two dead deer in one day, use additional record sheets.

Figure 1. Field form used for reporting dead deer found.

Cooperation by both supervisory and field personnel of the Bureau of Forest Pest Control was excellent. It is felt that very nearly all surveys and dead deer were reported, and forms were filled out carefully. Data for the two years represented complete coverage of 1.1 per cent of the deer range in the towns surveyed in the Adirondack region, 0.9 per cent in the Catskill region and 0.2 per cent in the central and western region.

The present paper considers only the data for the Adirondacks, where the surveys were confined mainly to the peripheral part of the region (Figure 2). This is the part where the deer population has failed to increase for many years. Portions of 178 towns in 14 counties were surveyed over the two years. The area surveyed represented 1.1 per cent of the deer range in the towns involved.

ANALYSIS OF DATA

The records were first sorted according to the reported condition of the carcass. If the description was "fresh", "meat and hide" or "hide (no meat)", the animal was considered to have died during the current year. If the remains were "hair and/or bone" only, death was considered to have occurred during some prior year. Only records for the current year were used for further analysis.

For each year (1965-66 and 1966-67), the current records were tabulated in three groups according to the time of the survey in relation to the deer hunting season, i.e., before, during or after. Also, for each of these groups, the corresponding total area of deer range surveyed was determined, and from this the number of dead deer found per square mile within that area was calculated. Next, for each group, the total area

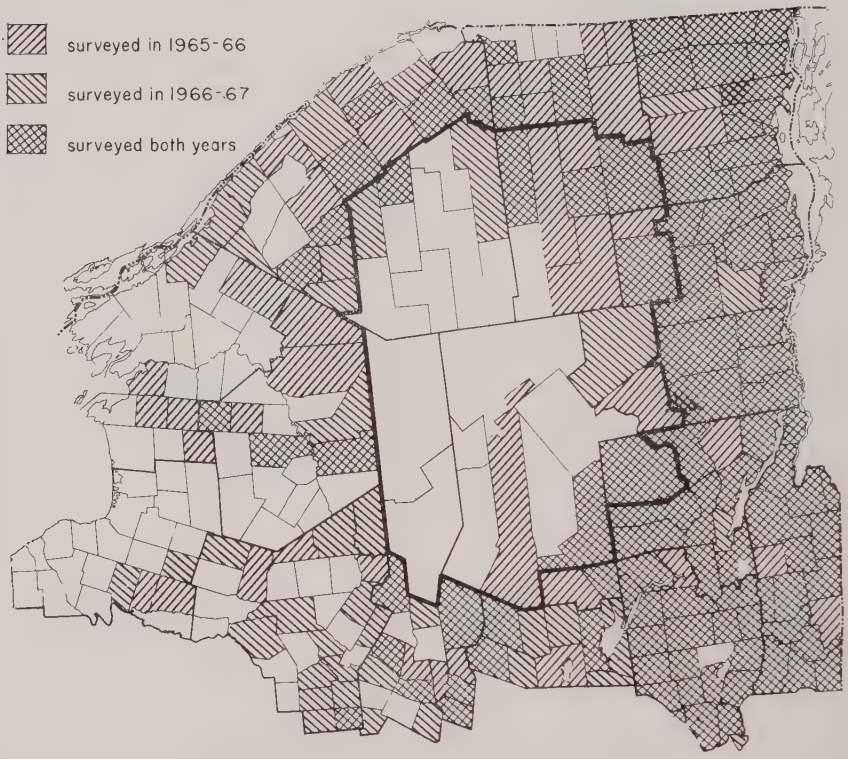


Figure 2. Towns in Adirondack region that were surveyed for dead deer.

of deer range in the towns covered by the survey was determined according to the figures given by Severinghaus and Sauer (1964), and from this the total number of dead deer in those towns was calculated by applying the frequency factor for the area surveyed. Then, again for each group, the legal harvest of bucks for the towns surveyed was determined from the annual calculated deer take (Free, 1966; Hesselton, 1967) and associated information, and the ratio between this and the corresponding total number of dead deer was computed.

These data are set forth in Table 1, and the locations of the current-year records used are plotted in Figure 3. There were no concentrations of losses, the dead deer being scattered throughout the area surveyed. The calculated number of dead deer in the towns surveyed totaled 1,951 for both years which was equivalent to 23 per cent of the corresponding legal harvest of bucks. With respect to the table, it may be noted that the areas of deer range in the towns surveyed for the three seasonal groups add to more than the total for a year because the survey crews worked in some towns for more than one season; but in the annual totals, as well as the total for both years, a given town is included

TABLE 1. NUMBER OF CURRENT-SEASON DEAD DEER FOUND IN AREA SURVEYED, TOGETHER WITH THE CALCULATED NUMBER OF DEAD DEER AND THEIR RELATIONSHIP TO THE LEGAL BUCK HARVEST IN THE TOWNS SURVEYED

Year and time of survey*	For area surveyed					For towns surveyed					
	Number of dead deer found		Deer range surveyed (sq. mi.)	Dead deer per square mile of deer range surveyed		Total deer range§ (sq. mi.)	Calculated number of dead deer§		Legal buck harvest§	Relationship of dead deer to buck harvest (per cent)	
	Total	Fawns and adult females		Total	Fawns and adult females		Total	Fawns and adult females		Total	Fawns and adult females
1965-66											
Before	0	0	10.61	..	..	3,484.1	..	..	2,070	..	..
During	3	3	16.41	0.183	0.183	4,404.8	806	806	3,048	26	26
After	5	4	37.19	0.134	0.108	5,737.2	769	620	4,642	17	13
Sub-total	8	7	64.21	0.125	0.109	8,573.1	1,072	934	6,511	16	14
1966-67											
Before	2	2	5.71	0.350	0.350	1,926.1	674	674	1,294	52	52
During	4	3	12.22	0.327	0.245	3,957.1	1,294	969	2,573	50	38
After	7	5	29.00	0.241	0.172	4,739.7	1,142	815	2,931	39	28
Sub-total	13	10	56.93	0.277	0.213	7,047.4	1,952	1,501	4,555	43	33
Total	21	17	111.14	0.189	0.153	10,326.9	1,951	1,580	8,325	23	19

*Time of survey refers to periods before, during and after deer hunting season.

§Sum of figures for the several time periods exceeds the totals given because some areas were surveyed during more than one time period but are included only once in each total.

Figure 3. Locations of current-year records of dead deer found in Adirondack region.

only once regardless of how many times it may have been surveyed. The same relationship applies to the figures for the legal harvest of bucks, except that, in the case of towns that were surveyed during both years, the larger of the corresponding harvest figures was used in the total for both years.

EFFECT OF LOSSES ON THE DEER POPULATION

To evaluate these known losses, it was necessary to determine the statistical limits of the data and to compare the degree of loss with the probable deer population on the area. Because losses of fawns and adult females are the most critical to population growth, only these losses were considered.

Dead deer (fawns and adult females) were found in only 14 towns (Figure 3), and only three towns had as many as two. Therefore, with respect to the probability of finding a dead deer in a given town, the assumptions of the Poisson distribution (Hodges and Lehmann, 1964) seem to apply, i.e., that "p" is near zero. Here, p was $14/178 = 0.08$.

The number of dead fawns and adult females found during the survey was 17. For a sample of this size, the lower and upper confidence limits (99 per cent) for the expected value of a Poisson distribution are 8.2 and 30.7 according to Beyer (1966, p. 191). Dividing these values by the area surveyed and multiplying by the total square miles of deer range in the towns represented gave estimates of the minimum and maximum numbers, respectively, of such dead deer in those towns. It is assumed that the survey was random, although the areas surveyed were not randomly selected and were therefore random only by chance. On this basis, the "true" total number of dead fawns and adult females over both years in the towns surveyed was somewhere between 764 and 2,850. This compares with the figure of 1,580 calculated directly from the data as shown in Table 1.

The total deer population in the towns surveyed was estimated to be 107,051 (Table 2), based on the legal harvest of bucks in these towns

TABLE 2. CALCULATED DEER POPULATION IN TOWNS SURVEYED

Hunting for antlerless deer	Male		Female		Total fawns and females	Total deer	Total deer range (sq. mi.)
	Fawn	Adult	Fawn	Adult			
Permitted	8,964	14,185	8,434	16,343	33,741	47,926	4,139.9
Not permitted..	11,058	17,500	10,405	20,162	41,625	59,125	6,187.0
Total	20,022	31,685	18,839	36,505	75,366	107,051	10,326.9

and applying the factors developed by Free et al. (1964) for the peripheral Adirondacks. The figures were also computed separately for the towns where antlerless deer could be hunted (under a party permit system) and for those where such hunting was not permitted.

It is estimated that such a population could lose, conservatively, 25 per cent of its fawns and adult females yearly and still increase. That the population in this area failed to increase over many years indicates that mortality among these age groups was greater than that. However, considering 25 per cent as the minimum that must have been taking place, documented losses accounted for 64 per cent of such mortality where hunting for antlerless deer was permitted and for only 9 per cent elsewhere in the towns surveyed (Table 3). In total, only 6,362 (34 per cent) of the 18,841 fawns and adult females being lost were accounted for. Apparently, some 12,500 others died without leaving evidence to be found in the field.

Some of the unaccounted-for loss obviously occurred among unborn and very young fawns, which would be impossible to detect by the survey methods employed. A substantial proportion, however, must have

Table 3. Relationship of Documented Losses of Fawn and Adult Female Deer in Towns Surveyed to Estimated Losses in These Age Groups That Must Have Taken Place

Hunting for antlerless deer	Documented losses			Estimated losses†	Relationship of documented to estimated losses (per cent)
	Calculated*	Legal harvest§	Total		
Permitted	633	4,782	5,415	8,435	64
Not permitted .	947	0	947	10,406	9
Total	1,580	4,782	6,362	18,841	34

*Calculated from the area of deer range as shown in Table 2 by applying the regionwide rate of 0.153 dead fawns and adult females per square mile recorded (Table 1).

§From Free (1966) and Hesselton (1967).

†Represent 25 per cent of total fawns and adult females in population as given in Table 2, i.e., the level of mortality that would still permit an increase in population and thus be the minimum occurring (see text).

been adult females. These deer are large enough that, if left in the field, most would have been found by the survey whatever the cause of death, with two exceptions. One major cause of death that would seldom be recorded was highway accidents where the deer died close to the road; animals that wandered from the road before they died would usually have been found. The other was illegal hunting where the carcass was removed from the field. Unfortunately, there are no data from which to assess the magnitude of losses from these causes.

The principal conclusion to be drawn from this study is that, since the deer population in the peripheral Adirondacks had not increased for many years, and since the losses that could be documented in the towns surveyed accounted for only 34 per cent of the total loss that must have been taking place among the fawns and adult females to prevent an increase in those towns, unknown losses were the paramount limiting factor. Of interest is the fact that, in the towns where hunting for antlerless deer was not permitted, documented losses accounted for only 9 per cent of the estimated total loss, whereas in the towns where such hunting was permitted the proportion accounted for was 64 per cent. This indicates that the legal harvest of antlerless deer took the place of certain of the unknown losses otherwise occurring. Nevertheless, any substantial increase in the deer population in this region will depend on a reduction in these unknown losses

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BREEDING AND PARTURITION DATES OF WHITE-TAILED DEER IN NEW YORK[1]

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ABSTRACT

Data were recorded for 894 pregnant female white-tailed deer, mostly road-killed animals, collected throughout the State from 1961 to 1968. Breeding dates were determined according to the embryo growth curve developed by Cheatum and Morton (1946). Fawns were found to have bred significantly later than older deer. Mean dates were December 6 for fawns, November 21 for yearlings and November 22 for deer 2½ years old or older. Corresponding parturition dates were June 25, June 12 and June 13. Physical condition as judged from the fat content of the femur marrow was not related to breeding date in any given animal. Mean and median breeding and parturition dates are given for 10 deer range sections of the State. Several limitations of the growth curve used are discussed.

The data presented here were obtained during a study of the status of reproduction among white-tailed deer (*Odocoileus virginianus*) in New York. They provide more comprehensive information on the dates of breeding and parturition in this species in the State than has heretofore been available.

MATERIALS AND METHODS

The data were collected throughout the State during the late winter and spring each year from 1961 to 1968. They were obtained mostly from road-killed deer, plus some killed by dogs and some shot illegally.

Collection of Data

For each pregnant female, the reproductive tract, femur and mandible were collected. From 1961 to 1966, collections were made by regional field personnel of the Division of Fish and Game. Then in 1967 and 1968, in order to obtain a larger sample, reports of dead deer were also solicited from county sheriffs, State police, the State Department of Transportation and the Thruway Authority. Arrangements were made

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[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-89-R. The authors wish to express their appreciation to all conservation officers, Bureau of Wildlife personnel, sheriffs' departments, State police and Department of Transportation and Thruway Authority field personnel who assisted in collecting deer. Special thanks are due Frank Church, Gideon Hanggi, Herbert Gaylord, Gary Parsons and Kenneth Dean who removed and stored the specimens and transported them to the Wildlife Research Laboratory. The manuscript was critically reviewed by C. W. Severinghaus and Stuart Free. Dr. N. S. Urquhart of New Mexico State University was consulted regarding statistical procedures.

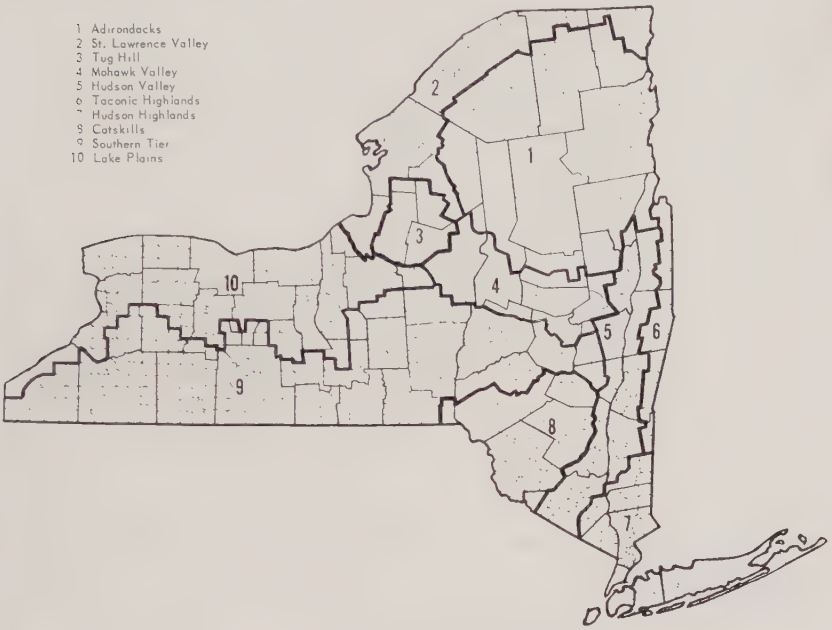

Figure 1. Deer range sections of New York according to McCaffery (1966).

for deer reported to be picked up by project personnel who removed the reproductive tracts and other material. These specimens were placed in plastic bags which were labeled and stored in commercial freeze lockers until they could be transported to the Wildlife Research Laboratory for examination.

Upon examination at the Laboratory, the crown-rump measurement was taken for the embryos present. From this, the dates of breeding and parturition were calculated according to data reported by Cheatum and Morton (1946). Also, for each pregnant doe, age was determined from the mandibular teeth according to Severinghaus (1949), and the fat content of the femur marrow was estimated as described by Cheatum (1949). The source of each specimen was recorded according to the deer range sections of the State recognized by McCaffery (1966) and shown in Figure 1.

Analysis of Data

The data were coded for computer tabulation, and both breeding and parturition dates were tabulated by month, day and range section for fawns, yearlings, adults and all ages. Statewide summaries for each age group were also made, and corresponding tabulations were made for deer having good bone marrow and those having poor bone marrow.

From these tabulations, an initial analysis was made of the mean and

median breeding dates by age group for each range section, but the resultant samples were too small to be meaningful. Therefore, the data for all sections were combined for each age group (see Table 1), and the data for all age groups were combined for each section (see Table 2). The records for parturition dates were treated in the same way. Also, for each category of bone marrow condition (i.e., good and poor), the records for all sections were combined according to age group.

Direct comparisons of breeding dates, and of parturition dates, were evaluated by the "*t*" test (Snedecor, 1956). For comparing these dates for deer with good bone marrow vs. deer with poor bone marrow, a linear regression using the arcsin transformation (Steele and Torrie, 1960) was employed in which the sums of squares were corrected by subtracting the factor $\frac{(\Sigma X)^2}{n}$. The level of significance for both test procedures was 0.05.

Definitions

Following are definitions, or manner of derivation, of various terms as used in this paper.

breeding date: derived for a given female by back-dating from the age of the embryo as determined from the growth curve developed by Cheatum and Morton (1946)

mean breeding date: derived by assigning consecutive numbers (beginning with 1) to the days from the first to last breeding dates recorded and multiplying each by the number of deer bred on that day, then dividing the sum of these values by the total number of deer bred and converting the resultant figure to the calendar date it represents

median breeding date: the day before which and after which half the females were bred

parturition date: derived by adding 202 days to the breeding date; mean and median parturition dates derived similarly

good bone marrow: 20 per cent or more fat content in femur marrow

poor bone marrow: less than 20 per cent fat content in femur marrow

RESULTS AND DISCUSSION

The distribution of the mean and median breeding dates and parturition dates for the 894 pregnant females examined is summarized in Tables 1 and 2. The data may be further analyzed with respect to the span of breeding and parturition as well as the influence of the age and

Table 1. Mean and Median Breeding and Parturition Dates of Female Deer in New York According to Age

Age (years)	Sample size	Breeding date		Parturition date		Total days between first and last breeding dates
		Mean	Median	Mean	Median	
½	120	Dec. 6	Dec. 2	June 25	June 21	100
1½	283	Nov. 21	Nov. 20	June 12	June 10	97
2½ and older	491	Nov. 22	Nov. 20	June 13	June 11	113
Total	894	Nov. 24	Nov. 22	June 14	June 12	126

Table 2. Mean and Median Breeding and Parturition Dates of Female Deer in New York According to Age

Range section	Sample size	Breeding date		Parturition date		Total days between first and last breeding dates
		Mean	Median	Mean	Median	
1	122	Nov. 28	Nov. 24	June 18	June 13	122
2	21	Nov. 28	Nov. 28	June 18	June 18	69
3	9	Nov. 27	Nov. 28	June 17	June 18	32
4	25	Nov. 27	Nov. 29	June 17	June 19	74
5	94	Nov. 23	Nov. 21	June 13	June 11	81
6	24	Nov. 25	Nov. 24	June 15	June 14	57
7	31	Dec. 2	Nov. 30	June 22	June 20	70
8	88	Nov. 23	Nov. 22	June 13	June 12	60
9	361	Nov. 22	Nov. 20	June 12	June 10	114
10	119	Nov. 24	Nov. 20	June 14	June 11	91

physical condition of the female. The need for more information concerning certain factors involved in the study is also discussed.

Breeding Dates

The frequency distribution of breeding dates for females of all ages with good bone marrow is shown in Figure 2. The records for deer with poor bone marrow were too few to warrant plotting, but the mean and median values are shown for comparison. Of all the deer with good bone marrow, 95 per cent were bred between October 28 and December 28. The earliest date was October 1 and the latest February 9.

This pattern of breeding corresponds closely to that reported by Cheatum and Morton (1946). It also corresponds to that of testosterone levels of male deer during the fall as recorded by Cheatum and Morton (1946) and Woslocki (1949). Apparently the breeding season is continuous once the rut has begun. Testosterone levels reach their peak during the last two weeks of November, and the majority of female deer are bred during the 20-day period from November 10 to 30. However,

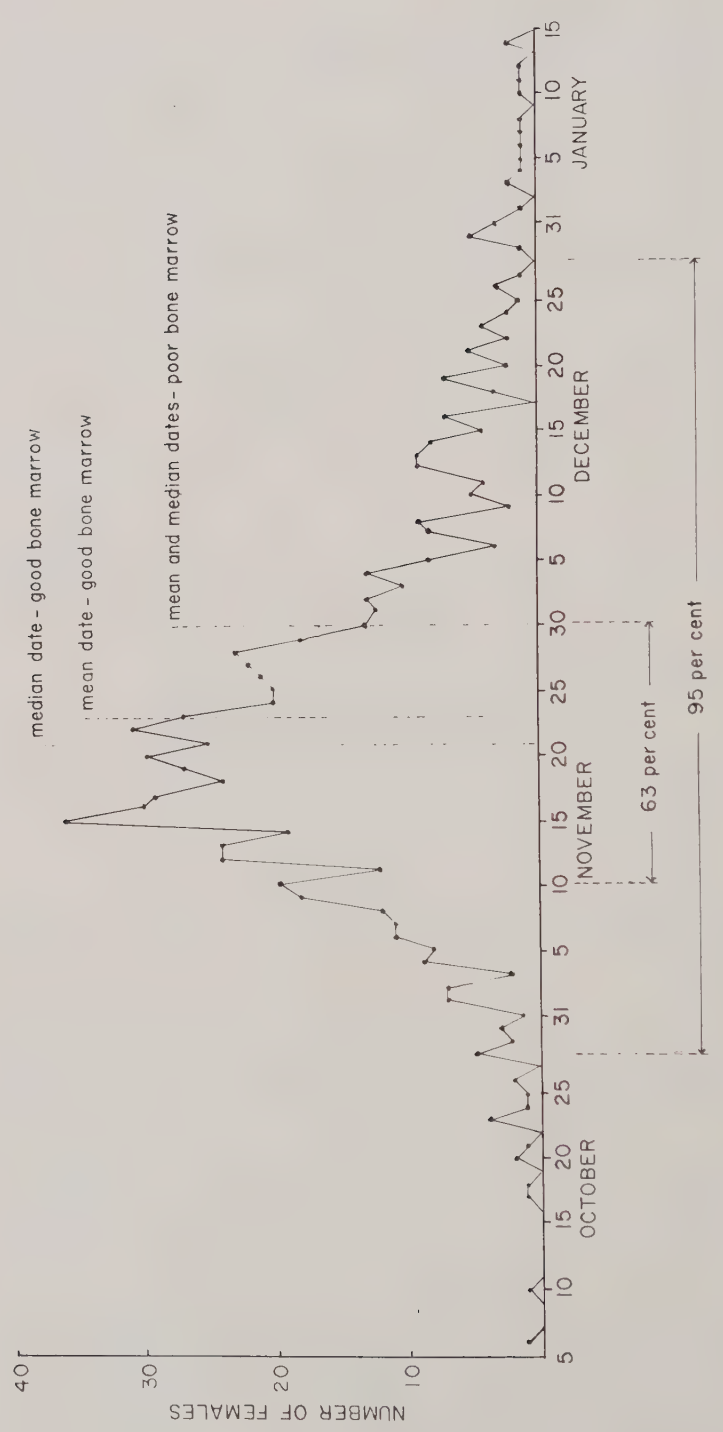

Figure 2. Distribution of breeding dates of female deer of all ages with good bone marrow. Percentage figures represent proportion of total that were bred between dates indicated.

breeding males are active through December and into January, and during this time fawns and older does that were either not in oestrus or not bred earlier may be bred. That breeding in the northern states takes place principally during the last two weeks of November has been shown by other studies: Massachusetts (Wislocki, 1949); Michigan (Verme, 1965); New York (Cheatum and Severinghaus, 1950).

For each age group, the mean breeding date for females with poor bone marrow was later than that for females with good bone marrow. Also, visual inspection revealed the same relationship when the data for all age groups were combined for each range section. However, statistical analysis revealed that the differences were not significant. Two counties, Delaware and Hamilton, representative of the poorest winter deer range in the State and also affording large samples of data, were selected because it was felt that a correlation between bone-marrow condition and breeding date, if it existed, would be apparent there. The data were compared by linear regression. Unfortunately, the number of records for fawns was insufficient for testing, but separate tests for yearlings and older deer in both counties gave "*r*" values of close to zero. It was concluded that there was no real correlation between bone-marrow condition and breeding date. Therefore, since a correlation would be less likely elsewhere, the data for the State as a whole were combined regardless of bone-marrow condition.

The mean and median breeding dates (Table 1) were closely similar for yearlings and older deer, but fawns bred some two weeks later than the others, the difference being highly significant when evaluated by the "*t*" test.

When the data for all ages were combined by range section (Table 2), the mean breeding dates ranged from November 22 in Section 9 to December 2 in Section 7, a spread of 10 days. Median dates ranged from November 20 in Sections 9 and 10 to November 30 in Section 7, also a spread of 10 days. Application of the "*t*" test revealed a significant difference between the mean dates for Section 7 and those for Section 9 ($t = 4.37$; $P = 1.96$). No other tests were made because sample sizes for some sections were not large enough.

Parturition Dates

Since the parturition date for each female was derived from its breeding date, the relationships are parallel. Based on the same specimens used for Figure 2, 95 per cent of the females would have given birth between May 18 and July 19. The earliest date was April 30 and the latest was August 30. Mean and median parturition dates are included in Tables 1 and 2.

Length of Breeding Season

The number of days between the first and last breeding dates did not

vary greatly among the three age groups (Table 1). But there were substantial differences between range sections (Table 2). The period of 32 days for Section 3, being based on only nine specimens, is probably not representative. Sample size may have been involved generally, however, since the longest periods were associated with the largest samples (Sections 1, 9 and 10). Records for individuals bred extremely early or late (a fawn was bred on February 9 in the central Adirondacks), which would greatly extend the period, would most likely occur in large samples. Fawns tend to extend the end of the period, and older deer the beginning. It may also be noted that on very poor range, where the nutritional level is low as described by Cheatum and Severinghaus (1950), females often have late oestrus cyles.

Other Considerations

Several aspects of the study involved factors on which more information is needed. These may be discussed briefly.

Embryo Growth The growth curve developed by Cheatum and Morton (1946), which was used for determining breeding dates from the size of embryos in the specimens examined, was based on a small sample of known-age embryos. They kept several female deer in captivity and maintained breeding-date records. These deer were then sacrificed or had Caesarian sections performed on them at various intervals after the breeding date in order to obtain known-age embryos at specific stages of gestation. A curve was then plotted using the data from these embryos plus a few fawns measured immediately after birth, i.e., a total of 26 specimens (11 sets of twins and four singletons). There are some slight inconsistencies in the curve and one notable inconsistency. The latter concerns a set of twins, born following a 202-day gestation period, that were 439 millimeters in length which corresponds to a point between 180 and 185 days on the smoothed curve.

Limitations revealed in the present study included records of "in utero" embryos as large as 545 millimeters long which fall beyond the growth curve and gross size differences between twin and triplet fawns of the same litter. Also, males in general were longer (and heavier) than females at any given stage of development as noted by Armstrong (1950).

Thus, embryos cannot be aged precisely by present techniques, and an error of several days can occur in deriving breeding and parturition dates from a given embryo. These errors are, perhaps, minimized when large samples of deer are used.

Physical Conditioning and Embryo Size Visual inspection of the data indicated that the mean and median breeding dates for females in poor condition (poor bone marrow) were consistently

later than those for females in good condition. Yet statistical analysis showed no correlation between physical condition at death and breeding date. Possibly, the condition of the female affects embryo size so that females with poor bone marrow may have produced smaller embryos which, when back-dated, gave later breeding dates.

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HEARTWORMS IN FOXES AND WILD CANIDS IN NEW YORK[1]

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ABSTRACT

Examination of the hearts of 811 wild carnivores in New York revealed infections with the heartworm *(Dirofilaria immitis)* in two of 551 red foxes and two of 51 wild canids. This is believed to be the first report of this parasite in the wild canid. Adult female worms in both wild canids and red foxes are capable of producing microfilariae. The hearts from 179 gray foxes were examined without finding evidence of heartworm infection.

The heartworm (*Dirofilaria immitis*) is a common parasite of dogs in the southern United States, and reports of its presence in the north are increasing. Detweiler et al. (1960) found infection with this worm to be one of the four most common types of heart disease encountered in a survey of 1,000 dogs in Pennsylvania. Hirth et al. (1966) found 7.7 per cent of 299 Connecticut dogs parasitized with it. Nine per cent of 550 mongrel dogs in south-central New Jersey had infections of heartworm (Lillis, 1964).

Heartworms have also been reported from cats, red foxes, coyotes, wolves, muskrats and several other mammalian species, including man (Levine, 1968). Schlotthauer (1964) found them in four of 83 red foxes *(Vulpes fulva)* in Minnesota. Walton et al. (1965) examined the blood of 48 gray foxes (*Urocyon cinereoargenteus*) and two red foxes from Fort Stewart, Georgia, without finding evidence of heartworm infection. To our knowledge, no reports have been published of heartworms in gray foxes. Gier and Ameel (1959) found them in the hearts of nine (0.6 per cent) of 1,390 western coyotes in Kansas. No reports are available concerning incidence in the wild canid. The wild canids of New York fit the general description of those from New Hampshire (Silver and Silver, 1969) which were designated eastern coyotes (*Canis latrans* var.). This study was undertaken to determine the incidence and importance of the heartworm in foxes (red and gray) in New York and to ascertain the possible role of foxes and wild canids in its epidemiology.

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-35-R. The authors wish to thank personnel of the New York Rabies Control Unit under the direction of Eugene Parks, associate wildlife biologist, for their invaluable assistance.

MATERIALS AND METHODS

The majority of the 811 hearts examined were collected as a function of the New York State Rabies Control Unit. Trappers removed the hearts and associated large blood vessels and preserved them in labeled containers of 10 per cent formalin. These hearts were later dissected and examined for heartworms at the Wildlife Research Laboratory at Delmar. The remainder were hearts from animals brought to the Laboratory by sportsmen and other members of the public for necropsy and determination of cause of death. Blood smears that were taken were fixed in absolute methyl alcohol and stained with Giemsa stain for microscopic examination for microfilariae. Adult heartworms recovered from infected animals were cleared in lactophenol, microscopically identified and examined to determine their level of sexual maturity.

The hearts were from 551 red foxes (35.2 per cent juveniles), 179 gray foxes (6.1 per cent juveniles), 51 wild canids (9.8 per cent juveniles), 26

Figure 1. Distribution by county of specimens examined for heartworm (*Dirofilaria immitis*) in New York. Number series indicate species composition in each case, i.e., red fox – gray fox – wild canid. Star represents positive case in that county.

skunks (*Mephitis mephitis*) and 4 bobcats (*Lynx rufus*). Their geographic distribution by county is shown in Figure 1.

FINDINGS

Heartworms were found in two of the 551 red foxes examined. Both were adult females, one from Wayne County (seven worms recovered) and one from Niagara County (four worms recovered). Heartworms were also found in the hearts of an adult male wild canid from Warren County and a young male wild canid from Ulster County. The locations from which these four positive cases came are shown in Figure 1.

The last animal is the only heartworm-positive case for which complete necropsy results are available. Body weight was 35 pounds. Organ weights were as follows: heart, 194 grams; liver, 394 grams; spleen, 32 grams; kidneys, 58 grams and 63 grams. The hypertrophied right ventricle and pulmonary artery contained 17 adult heartworms, some of which were entwined about the chordae tendonae (Figure 2). This wild

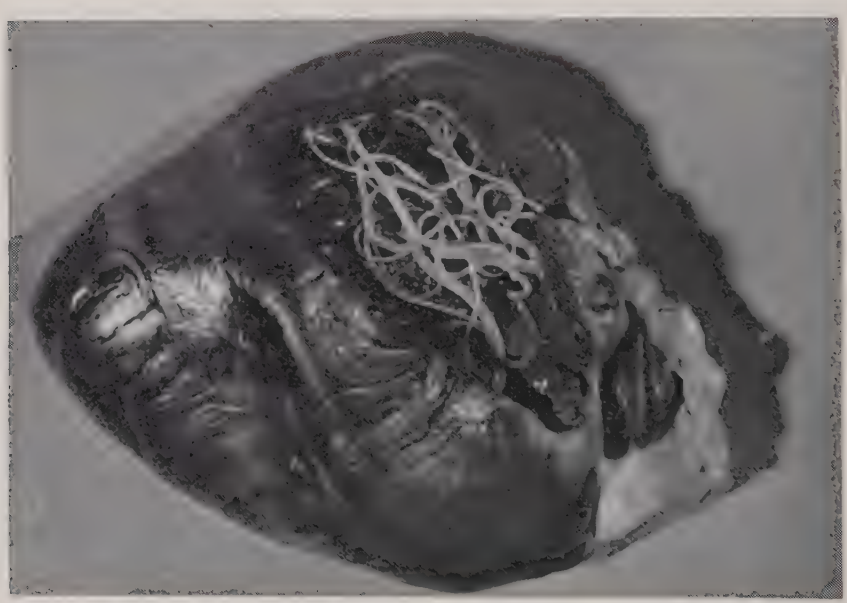

Figure 2. Heart of male wild canid from Ulster County (N.Y.) showing adult heartworms (*Dirofilaria immitis*) in the right ventricle and entwined around the chordae tendonae.

canid also had dog fleas (*Ctenocephalides canis*) and dog ascarids (*Toxocara canis*). Giemsa-stained blood smears showed numerous microfilariae of the heartworm.

Examination of blood for microfilariae was not possible in the other three instances of infection. The female heartworms recovered from the red fox from Niagara County were sexually mature and actively producing microfilariae, while those recovered from the Wayne County specimen contained developing ova but no microfilariae.

No heartworms were found in any of the gray foxes, skunks or bobcats.

The incidence of heartworms in the specimens examined in this study was 0.49 per cent. In red foxes it was 0.36 per cent and in wild canids, 3.92 per cent.

DISCUSSION

Since hearts obtained during trapping operations were preserved along with only a limited portion of the large vessels, it is possible that some cases of heartworm infection were missed. Heartworms are sometimes found in the pulmonary artery and its branches. For example, Hirth and Nielsen (1966) reported them from the medium-size pulmonary vessels and lungs of a red fox. Less often, they may be found in the venae cavae of dogs. On occasion, the worms have been found in other locations in the dog such as the bronchioles, brain, femoral arteries (Catcott, 1968) and cerebral arteries (Olson, 1970). The right ventricle is, however, by far the most common location.

Development of heartworm infection after initial exposure to the microfilariae is a relatively long process. The larvae require 85 to 120 days to reach the heart and another 100 to 120 days for maturation (Catcott, 1968). Therefore, in some juvenile animals, the worms might not yet have reached the heart, and some of the adults may have had prepatent infections.

Heartworm infection in these wild carnivores must be examined both as a morbidity/mortality factor and as a reservoir for infection in domestic dogs.

In its effects on the wild host and its populations, the heartworm does not appear at present to be very important. The extent of effect of the parasites could only be examined in the case of the young male wild canid from Ulster County for which associated data were recorded. The right ventricle of this animal was hypertrophied, and the heart weighed 194 grams. In other wild canids of comparable size (31-37 pounds), heart weights averaged 121 grams with a range of 100 to 153 grams. Hirth et al. (1966) stated that only a few of 23 heartworm-infected dogs showed typical clinical signs, e.g., non-productive cough, weight loss or fatigue upon exercise. Indirect losses due to a decrease in stamina may be the most important effect of this parasitism in foxes and wild canids.

The numbers of worms (four and seven) found in the infected red foxes in this study were fairly low compared with levels commonly found in dogs. However, the red fox is a much smaller animal, with a smaller heart, than the average dog, and relatively low heartworm loads may be pathogenic. Lillis (1964) found an average of 9.4 worms (range 1-49) per infected dog and less than two worms per infected cat. Hirth

and Neilson (1966) found eight worms in one red fox and 40 in another. At the latter, higher level of parasitism, the parasite undoubtedly is more pathogenic.

Heartworms in foxes and wild canids may be important as a reservoir for infections in dogs. In order to serve as reservoir hosts, the wild carnivores must be capable of supporting full development of the heartworm to sexual maturity and microfilarial production. Hirth and Nielsen (1966) found no microfilariae in adult female worms recovered from two red foxes in Connecticut. Adult female worms recovered from one of the red foxes in the present study showed developing ova in the uterus. Adult females from the second infected fox contained fully developed microfilariae. Assuming that these were normal, viable microfilariae, it appears that the red fox can serve as a definitive host for *D. immitis*. Circulating microfilariae were found in the blood of the one infected wild canid which was completely examined. Thus, this species also may be a reservoir host.

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ADDENDUM

Since the foregoing work was completed, a single case of *Dirofilaria immitis* has been found in a gray fox in New York. This fox was an adult male shot in Poughkeepsie in Dutchess County on February 11, 1972. The right atrium contained eight adult and immature *D. immitis* in and around a fibrinous clot. One worm extended into the right ventricle. There was hypertrophy of the right side of the heart. A single adult female worm contained ova in an early stage of development. There were no microfilaria of the heartworm in the lung blood. This is the first heartworm infection seen in a gray fox, although over 320 have been examined. This fox also had canine distemper, histologically confirmed by both Shorr's and Seller's stains of urinary bladder epithelium.

AGING RED FOXES *(VULPES FULVA)* BY COUNTING THE ANNULAR CEMENTUM RINGS OF THEIR TEETH[1]

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ABSTRACT

Counting the annulations in the cementum of the teeth appears to be an accurate and reliable means of determining age in red foxes. The technique was 90 per cent accurate when applied to the teeth of 50 known-age red foxes in New York. The molars and premolars were superior to the canines for this purpose. The method was also used to determine the ages of 15 wild red foxes.

In order to understand the population dynamics of a wildlife species, an accurate method of aging individuals is needed. At the present time, the red fox population in New York seems to be seriously affected by sarcoptic mange (Stone et al., 1971, 1972), distemper and rabies, yet little is known of the population dynamics of this species. Further studies of these problems, as well as management measures, depend in part on a more complete knowledge of present population structures and their trends. An accurate and practical method for aging red foxes is a necessary means to that knowledge, and cementum-ring counts of tooth sections appear to be such a method.

Counting annular layers in the cementum of the teeth is a relatively recent technique for aging wild mammals. It has long been noted that layering occurs in the tooth parts of many species, especially in the dentine where layers may be readily apparent without magnification. It has also been shown that production of the layers in both dentine and cementum is usually an annual phenomenon. Rausch (1961) estimated the age of black bears by counting the layers of dentine in the canine teeth. He also noted that the cementum was made up of layers which might be age indicators but which were often difficult to count. Klevezal and Kleinenberg (1967) suggested that, though annular layers may be present in a number of different mammalian bony tissues, tooth cementum is the most suitable for age determination because it is not

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project W-35-R. The authors wish to thank Peggy R. Sauer, Department of Biology, State University of New York at Albany, for preparing histological sections and for valuable suggestions. They would also like to thank Frances Parks and Gary Will for examining tooth sections and assigning ages.

like periostial bone, subject to resorption and because it is not, like dentine, spatially limited in its growth. Layering in cementum is less confused by accessory bands than is layering in dentine.

The cementum-ring counting procedure for aging animals has been used for various ungulates, including white-tailed deer (Gilbert, 1966; Ransom, 1966; Sauer, 1971), black-tailed deer (Low and Cowan, 1963) and moose (Sargeant and Pimlott, 1959; Simkin, 1968). The technique has also been used for determining the age of carnivores, especially bears (Craighead et al., 1970; Marks and Erickson, 1966; Mundy and Fuller, 1964; Rausch, 1969; Sauer et al., 1966; Stoneberg and Jonkel, 1966). Linhart and Knowlton (1967) described the use of the technique for coyotes after examining the teeth from 30 known-age skulls. Similar studies have been reported for arctic foxes from Russia by Kleinenberg and Klevezal (1966). Jensen and Neilsen (1968) applied the technique to red foxes from Denmark, but they had available only five known-age specimens. Johnston and Beauregard (1969) examined cementum layers of the upper left canine tooth as an aging technique for red foxes; however, it is difficult to determine from their paper how effective the method was.

Preliminary investigations in 1968 and 1969 under the New York State wildlife rabies control program indicated that distinct annular growth layers in the cementum of molar teeth from red foxes could be identified by sectioning. The present study was undertaken to test the technique by applying it to a larger sample of known-age animals and to determine which teeth might be best suited for the purpose.

MATERIALS AND METHODS

Teeth from 50 (27 male and 23 female) known-age, captive red foxes (*Vulpes fulva* var. silver) were processed for microscopic examination. Age distribution of these specimens was as follows: 6 months, 10; 1½ years, 17; 2½ years, 11; 3½ years, 12. The teeth were decalcified in 20 per cent formic acid, rinsed and sectioned by the method described by Sauer et al. (1966). Canines, premolars and molars were sliced sagittally; canines were also cut transversely. The sections, approximately 25μ in thickness, were stained with haematoxylin and eosin.

The sections were studied by three independent observers, one with little technical training. Each observer judged the age of each animal from the canine teeth and from the premolar-molar teeth. The observers were ignorant of both the age distribution and the upper age limit of the specimens when the sections were examined.

Teeth from 15 wild red foxes (10 male and 5 female) were processed in the same manner to verify that similar annular cementum patterns occur in wild foxes. Age was determined from these sections by a single observer.

FINDINGS

The premolar-molar teeth proved more reliable than the canine teeth for age determination (Table 1). Most incorrect estimates deviated from the true age by only 1 year. Based on the canines, accuracy was 45.7 per cent, and, although the sections were well-cut and stained,

TABLE 1. NUMBER OF KNOWN-AGE RED FOXES, AGED FROM SECTIONS OF THEIR CANINE TEETH AS WELL AS FROM SECTIONS OF THEIR PREMOLAR TEETH, ACCORDING TO THE NUMBER OF OBSERVERS WHO DETERMINED THE AGE CORRECTLY

Age (years)	Number of specimens	Number of specimens according to number, of three observers, who determined age correctly							
		Canine teeth				Premolar-molar teeth			
		0	1	2	3	0	1	2	3
½	10*	..	..	2	..	..	..	5	5
1½	17*	4	2	3	1	1	..	3	13
2½	11	1	2	8	..	..	1	4	6
3½	12	5	5	2	..	2	1	6	3
Total	50*	10	9	15	1	3	2	18	27
Degree of accuracy (per cent) §		45.7				90.0			

*Sections were cut from the canine teeth of only two ½ year olds and ten 1½ year olds.

§Represents proportion aged correctly by at least two observers.

all three observers had difficulty reading them. Using the premolar-molar teeth, all three observers correctly determined the age of 27 of the 50 specimens, and two of the three agreed on the age of 18 others. This is considered to have been an accuracy of 90 per cent since 45 specimens were aged correctly by two of three of the observers. No differences in annulations were noted between male and female foxes.

Figures 1 to 3 show cementum development in several known-age foxes. Not all samples are so clear-cut as these. Clarity of the cementum rings varies with the particular tooth examined and with the part of the tooth that is observed. It was found that molars or premolars, observed at the apex of the root (Figure 3) or at the gingival line (Figure 2), gave the clearest readings.

The 15 wild red foxes studied were trapped between July and October in 1969 and 1970. Of three that had been recorded as juveniles by the trappers, two were found to be young-of-the-year males and the other was a 1-year-old female. The remaining foxes comprised six 1 year olds, three 2 year olds, one 3 year old and two 4 year olds.

Figure 1. Section of cementum of premolar tooth from a 3½-year-old known-age red fox. (100×)

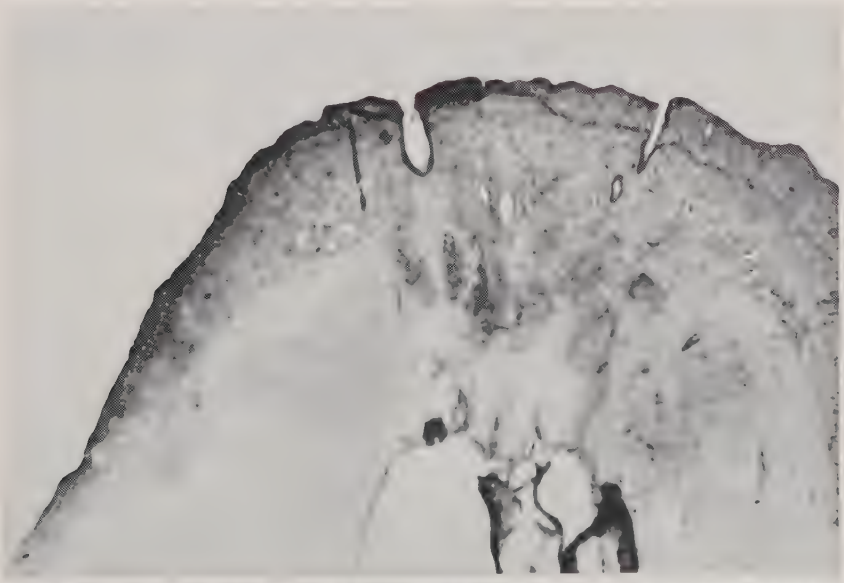

Figure 2. Section of apex of root of premolar tooth from 11½-year-old known age red fox; the apex of the root is generally the best area of a tooth for distinguishing cementum rings. (40×)

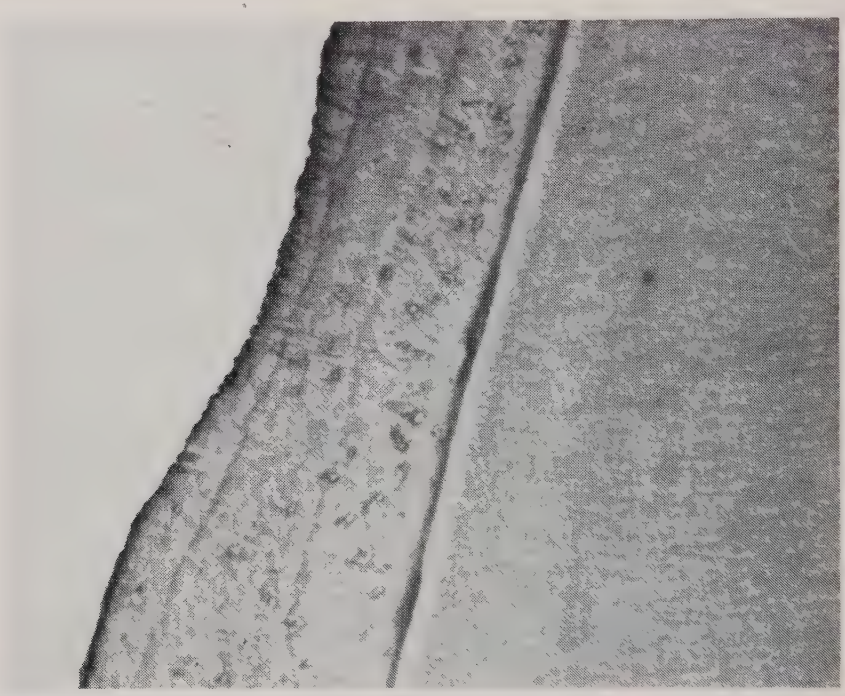

Figure 3. Section at gingival line of premolar tooth from a 2½-year-old known-age red fox; cementum rings in sections made at or near the gingival line are relatively easily read. (100×)

DISCUSSION

Similar attempts to estimate the ages of carnivores have been primarily based on cementum-ring counts of the canine teeth. Jensen and Nielsen (1968) in their study of European red foxes (*Vulpes vulpes*) used the canine teeth of the lower jaw for cementum-ring counts because the cementum layer on these teeth is thicker and they considered the canines large enough to handle easily. Linhart and Knowlton (1967) used the cementum rings of the canines to age coyotes. Sauer et al. (1966) and Rausch (1969) counted the cementum rings in the canines of black bears. Mundy and Fuller (1964) determined the age of grizzly bears by counting cementum rings of the third molar. Craighead et al. (1970) extracted the left and right fourth premolars in alternate years from both known-age and unknown-age grizzly bears in Yellowstone National Park. Ransom (1966) used molar M_1 for age determination of white-tailed deer. In the present study, it was found that cementum rings in the molars and premolars of red foxes were more easily and more accurately distinguished and counted than were the rings in the cementum of the canine teeth. Premolars, being more

easily processed than molars, are the most suitable teeth for aging by cementum-ring counts in red foxes.

Sauer et al. (1966) and Rausch (1961) determined that counting annulations in the cementum or dentine was an invalid and/or impractical technique for use on captive bears. Sauer found that annulations in the cementum of captive bears were either faint or nonexistent; Rausch stated that captive bears grow at an accelerated rate and, though dentine layers may still be annual, they are often difficult to interpret. Linhart and Knowlton (1967) in their studies of coyotes made no mention of any differences in layering between the teeth of captive and wild animals, though both were used. No differences were noted between the teeth of captive and wild red foxes in the present study, with the possible exception of increased clarity of layering in the wild red foxes.

Rausch (1969) suggested that in bears the layers in the dentine and cementum were due to a slowing of growth during the period of denning — the dark layers being formed during denning and the light bands during the period of activity and growth. Stoneberg and Jonkel (1966) noted the beginning of dark-layer formation before denning and felt that there might be another reason for the changes in cementum production. Craighead et al. (1970) and Klevezal and Kleinenberg (1967) discussed the literature available concerning the causes of formation of annual layers in the teeth.

Linhart and Knowlton (1967) found that the first opaque layer in the cementum of coyotes did not form until between the 20th and 23rd months of life. Age was determined in younger animals by the eruption status of the permanent canines and extent of closure of the root canal. Jensen and Nielsen (1968) used the cementum-ring-count technique for foxes over 1 year old. They noted that the first dark layer was laid down in the cementum during the spring and summer of the second year of life. Animals less than 1 year old were separated from older foxes by examining the epiphysis of the radius and the surface structure of the bone.

The 50 known-age foxes in the present study were sacrificed during December. Therefore, red foxes approximately 1½ years old would be expected to show one completed dark layer of cementum and ongoing formation of a lighter layer. This was found to be the case.

Until formation of the first dark layer is complete, age cannot be determined with any confidence by this method. Accumulations of the stain used on the histological section may appear at the outer edges of the cementum, making it difficult to tell whether or not there is a dark band in the process of formation. Because of this, it may be difficult to separate young-of-the-year animals from yearlings. It is recommended that the age of animals less than 1 year old be initially determined by

another method, such as the epiphysial-fusion technique used by Jensen and Nielsen (1968).

Reilly and Curren (1961) separated young-of-the-year foxes from adults by examining the degree of ossification of the humeral epiphysis. They found, by regular X-ray examination of the proximal epiphysis of the humerus, that the epiphysis closed at approximately 9 months of age. They also used the "groove test" on the epiphysial plate of the humerus and found it practical and reliable for juvenile foxes taken from May through November.

It appears from this work that premolar or molar tooth sectioning can be used as a satisfactory method of aging red foxes, and that the tooth-sectioning technique will be helpful in studying red fox population dynamics. There remains a need to study sections of premolar and molar teeth from red foxes beyond their fourth year of life to determine if the technique is as accurate for older age groups. It is suggested that technicians practice reading tooth sections from known-age foxes and be checked for competence in using the technique. Where possible, sections should be read by several experienced technicians and the consensus taken as the age.

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SERUM PROTEIN PATTERNS OF WHITE PERCH[1]

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ABSTRACT

Eight serum protein fractions were discerned for white perch. Protein fraction percentages differed by geographic area and size of fish, as well as because of stress. Total proteins and hematocrits did not differ significantly in fish sacrificed in the field. Laboratory fish had reduced hematocrits.

The purposes of this study were (1) to determine the serum protein patterns of white perch (*Morone americanus*) and (2) to determine the effect of stress (maintaining fish in the laboratory) on the serum proteins. Total proteins and hematocrits were also determined.

Electrophoretic studies indicate that blood protein fractions of fish may change due to stress. Changes in serum protein fractions have been reported in fish exposed to U.D.N. infection (Mulcahy, 1969, 1971), prolonged starvation and exposure to industrial wastes (Fujiya, 1961), inorganic chemicals (Neuhold and Sigler, 1960), temperature of acclimation (Meisner and Hickman, 1962) and a diurnal oxygen pulse (Bouck and Ball, 1965). Stressful methods of capture can induce significant changes in plasma proteins (Bouck and Ball, 1966). However, percentages of serum protein fractions of exercising and resting fish were reported to be similar (Yamashita, 1968).

MATERIALS AND METHODS

White perch were collected by seining from (1) the Hudson River off Grassy Point (N.Y.), (2) Deal Lake at Asbury Park (N.J.) and (3) the Mullica River at Lower Bank (N.J.). Deal Lake is located approximately midway (75 miles) between the Hudson River and the Mullica River. The fish were collected between August 1 and 29 in 1971.

Most of the fish were weighed and sacrificed immediately after collection. Several (from Deal Lake and the Mullica River) were brought to the laboratory where they were maintained in aged, aerated tap water (22° C.) and fed minced clams daily until they were sacrificed. Blood was collected, in nonheparinized 50-lambda tubes, from the caudal artery after the tail had been severed. All samples were centrifuged for 4 minutes, after which the hematorcrits were determined. Then the samples were refrigerated for 1 to 5 days until they were analyzed.

[1]Thanks are extended to David Dorfman and Dr. B. Shidlovsky for assistance in collecting the fish. The author is grateful to the members of the Pathology Department at Riverview Hospital (N.J.) for the use of the spectrophor and to J. Dushey for data processing. This project was supported in part by the Monmouth College Grant in Aid for Creativity Fund.

Electrophoresis was performed with a Bausch and Lomb Spectrophor I. The gel consisted of 0.2 per cent Agarose and 6 per cent buffer. The buffer consisted of one part 8 per cent pyrophosphate and 10 parts water adjusted to a pH of 8.5 with concentrated hydrochloric acid. The pH of the working concentration was 9.1 A string to which 0.5µl of serum had been applied was immersed in the gel, and 75 volts were applied for 5 minutes followed by 360 volts for 20 minutes. The pattern was scanned and an integration line obtained.

To compare the electrophoretic patterns obtained, normal human serum(Moni-trol I) was used. Total proteins were determined by the Accu-stat™ System.[2]

Comparisons of the serum proteins, total proteins and hematocrits were made by analysis of variance. Arcsin transformations of the percentages obtained for the serum proteins and hematocrits were made for the analyses. Fish were compared by geographic area and by size. For size, they were grouped as small (under 5 grams) and large (5 grams or more). For small fish from Deal Lake, proteins and hematocrits from specimens held in the laboratory were compared with those of specimens sacrificed in the field.

RESULTS

Three major serum protein fractions (designated A, B and C) and five lower mobility fractions (D, E, F, G and H) were separated in the white perch analyzed (Figure 1). The percentage serum protein fractions of these fish are summarized in Table 1.

Comparisons by geographic area indicated that Hudson River fish differed significantly ($P = 0.01$) from Deal Lake fish in two of the eight fractions (B and E) and from Mullica River fish in six (A, B, D, E, G and H). Perch from Deal Lake differed significantly from Mullica River fish in fractions A, D, F and G.

Large perch differed significantly from small perch in every fraction but F. By geographic area, large and small perch from the Mullica River did not differ significantly in any fraction, whereas among the Hudson River and Deal Lake fish the size groups differed in five (A, B, D, G and H) and four (A, B, C and G) fractions, respectively.

For perch from Deal Lake, the serum proteins of laboratory fish (held 17 to 38 days) differed significantly ($P = 0.01$) in fractions B, C and D from those of fish sacrificed in the field. For two laboratory fish from the Mullica River that developed fin rot and were sacrificed after 4 days, the serum protein patterns had reduced A fractions and grouped, elevated fractions D, E, F and G (Table 1 and Figure 1).

[2]Catalog #2022, Clay Adams, Division of Becton, Dickinson and Co., Parsippany, New Jersey.

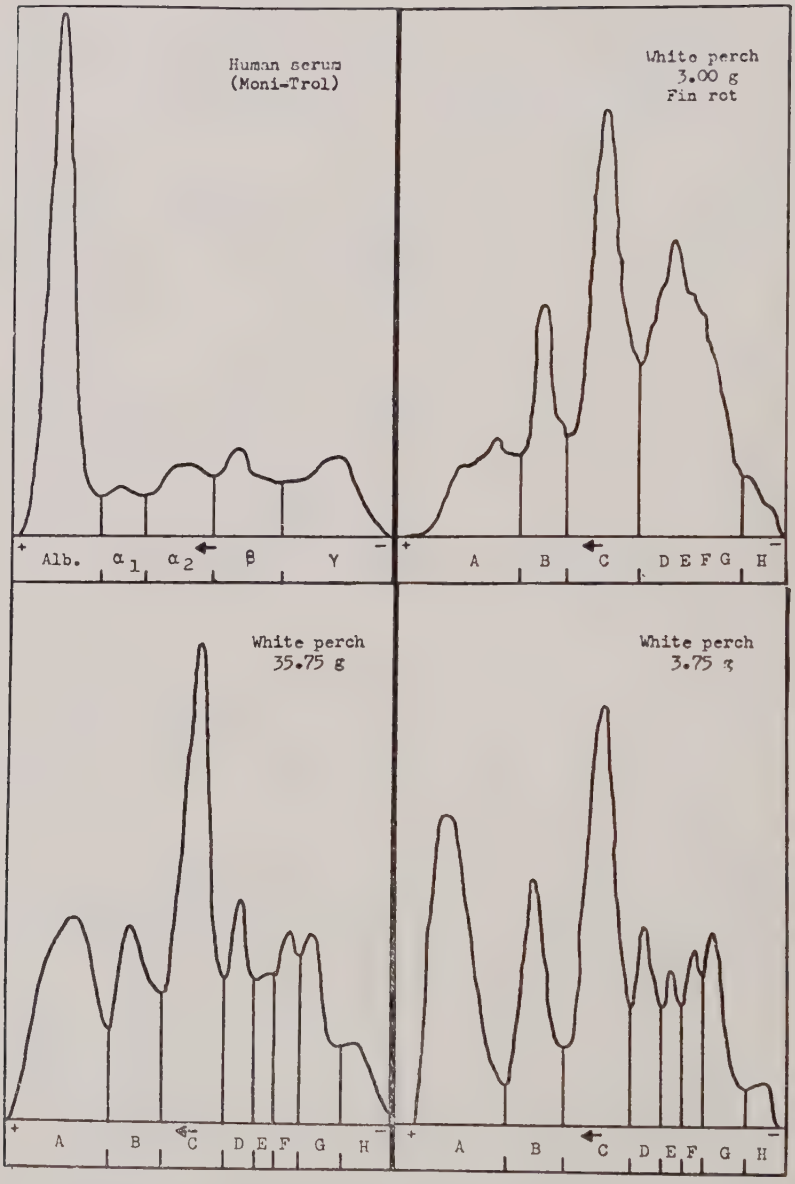

Figure 1. Serum protein patterns of small and large white perch and of specimen with fin rot, compared with that of human serum (Moni-Trol). Arrows indicate direction of protein migration.

Total proteins, obtained only from the large fish, did not differ significantly between geographic areas (Table 2).

Hematocrits did not differ significantly by geographic area (Table 3)

TABLE 1. SUMMARY OF THE SERUM PROTEIN FRACTIONS (IN PER CENT) OF LARGE (5 GRAMS AND OVER) AND SMALL (UNDER 5 GRAMS) WHITE PERCH

Size of fish*	Value	Serum protein fraction A	B	C	D	E	F	G	H
Hudson River§									
Large (20)	Mean	20.8	13.6	28.9	10.2	5.9	6.0	8.6	6.0
	Range	15–28	11–18	20–35	7–13	4–11	3–10	4–12	3–13
Small (23)	Mean	28.0	15.9	27.8	8.4	5.1	5.6	6.8	2.4
	Range	21–35	11–22	23–34	4–12	3–10	2– 8	4–13	1– 5
Deal Lake§									
Large (8)	Mean	22.3	13.6	29.8	10.8	4.4	4.8	9.0	5.3
	Range	19–27	12–16	27–32	8–13	1– 7	2– 8	7–11	0– 9
Small (20)	Mean	29.0	20.0	26.2	8.7	3.7	4.7	5.5	2.2
	Range	25–36	15–24	22–32	6–11	2– 5	2– 8	4– 8	1– 4
Mullica River§									
Large (8)	Mean	28.4	18.4	27.6	7.2	3.5	6.2	5.9	2.8
	Range	23–32	16–22	24–31	6– 9	2– 5	5– 8	5– 8	1– 6
Small (25)	Mean	30.0	19.5	27.1	7.2	3.2	6.0	5.1	1.9
	Range	26–36	15–23	23–34	5–10	1– 6	4– 9	3– 8	1– 5
Total§									
Large (36)	Mean	23.3	14.6	28.7	9.6	5.0	5.7	8.0	5.1
	Range	15–32	11–22	20–35	6–13	1–11	2–10	4–12	0–13
Small (68)	Mean	29.0	18.3	27.6	8.0	4.0	5.5	5.6	2.0
	Range	21–36	11–24	22–34	4–12	1–10	2– 9	3–13	1– 5
Total (104)	Mean	27.0	17.1	27.6	8.6	4.4	5.6	6.6	3.1
	Range	15–36	11–24	20–35	4–13	1–11	2–10	3–13	0–13
Deal Lake									
Small (13)	Mean	26.8	16.1	30.1	11.7	3.9	4.0	6.1	1.3
	Range	21–33	12–19	25–38	8–15	2– 8	0–11	3– 9	0– 4
Mullica River									
Small (2)	Mean	20.0	14.5	29.5	33.0				3.0
	Range	20	14–15	28–31	31–35				3

* Figures in parentheses indicate number of fish.

§ Fish sacrificed in the field.

Laboratory fish.

or by size. Among perch from Deal Lake, hematocrits of fish maintained in the laboratory did not differ significantly from those of fish sacrificed in the field. For fish from the Mullica River, the two that developed fin rot in the laboratory had hematocrits considerably below those of fish sacrificed in the field.

Table 2. Total Proteins (in grams per 100 Millimeters) in Blood Sera of Large (5 grams and over) White Perch

Site*	Mean	Range
Hudson River (19)	6.34	5.4 – 7.5
Deal Lake (5)	5.76	5.2 – 7.0
Mullica River (6)	6.20	5.6 – 6.9

* Figures in parentheses indicate number of fish.

Table 3. Hematocrit Values (in per cent) of White Perch Blood

Site	Field fish		Laboratory fish	
	Mean*	Range	Mean*	Range
Hudson River	60.0 (41)	41–74	..	..
Deal Lake	52.0 (21)	41–63	47.5 (13)	41–59
Mullica River	55.0 (29)	45–62	35.0 (2)	33–37
Total	56.5 (91)	41–74	xxx	xxx

* Figures in parentheses indicate number of fish.

DISCUSSION

The intraspecific differences in serum-protein patterns of white perch in the populations observed in this study may be due to either inherent genetic variability or extrinsic environmental factors, or both. Water temperatures in the three seining areas were 26° C. Salinities at seining sites were: 1.1 ppt in the Hudson River; 0 to 2.2 ppt in Deal Lake; and 5.6 ppt in the Mullica River. Variations in protein patterns within fish species have been observed for serum proteins (Mairs and Sindermann, 1960; Fujiya, 1961; Nyman, 1965), muscle proteins (Gray and McKenzie, 1970) and eye lens proteins (Tsuyuki et al. 1968).

The extent of variability in the serum-protein patterns of normal fish may limit the usefulness of electrophoresis as a technique for the early detection of certain stress factors. If serum proteins of certain fish species, such as the white perch, were to be used as indicators of stress in particular bodies of water, normal serum-protein patterns of the indicator species should be obtained for such waters. The species could then be monitored periodically.

The reduction of the leading serum protein fraction (A) which is similar in mobility to the human albumin fraction, and the corresponding increase in the low-mobility fractions (D, E, F and G), in the two fish with fin rot is similar to that reported for fungus-infected sea

herring (Sindermann and Mairs, 1958) and for heavily diseased Atlantic salmon and trout (Mulcahy, 1969, 1971).

Serum protein patterns and hematocrits were successfully determined for white perch as small as 0.75 gram. Total proteins from fish weighing less than 5 grams were not available because of their small quantity of blood serum.

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BIRD DAMAGE TO FIELD CORN IN NEW YORK IN 1971[1]

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ABSTRACT

A survey of damage by birds to field corn in New York was made in October of 1971. Data for 159 fields in 18 counties indicated a mean loss of 0.468 bushel per acre. Losses were greatest in the Hudson Hills, Finger Lakes and Lake Plain regions and least in the Plateau and Central Plain. Red-winged blackbirds were responsible for most of the damage. Reasons for losses being less than those in 1970 are discussed.

Bird damage to field corn in the United States averaged 0.111 bushel per acre in 1970 according to a recently completed survey (Stone et al., 1972). Of the 24 states included in the survey, New York showed the highest average loss to birds, with a mean of 1.179 bushels per acre. In order to examine further the importance and characteristics of the damage in New York, and to test and refine the sampling method used in the 1970 survey, a more intensive study was completed in 1971. The results of the study are presented here.

METHODS

The corn-damage survey was conducted from October 1 to October 9 in 18 New York counties. Counties selected for appraisal were those which contained damaged fields in the 1970 survey. Agricultural lands in the counties to be sampled were delineated through use of a farming viability map of New York (Conklin and Linton, 1969a). All mapped agricultural lands in the 18 counties were divided into square-mile blocks by using a transparent plastic grid and were numbered consecutively for each county.

In each county, at least four, 9-square-mile blocks were selected randomly from the numbered grid. In all, 159 blocks were chosen, in numbers proportional to corn acreages in each county. Within each 9-

[1] The authors wish to thank John Peterson, Region 5 pesticide specialist of the U. S. Fish and Wildlife Service, for assisting in the survey and Noel Cutright, PhD candidate at Cornell University, for helpful comments. Ann Jones and Jerome Besser kindly reviewed the Manuscript.

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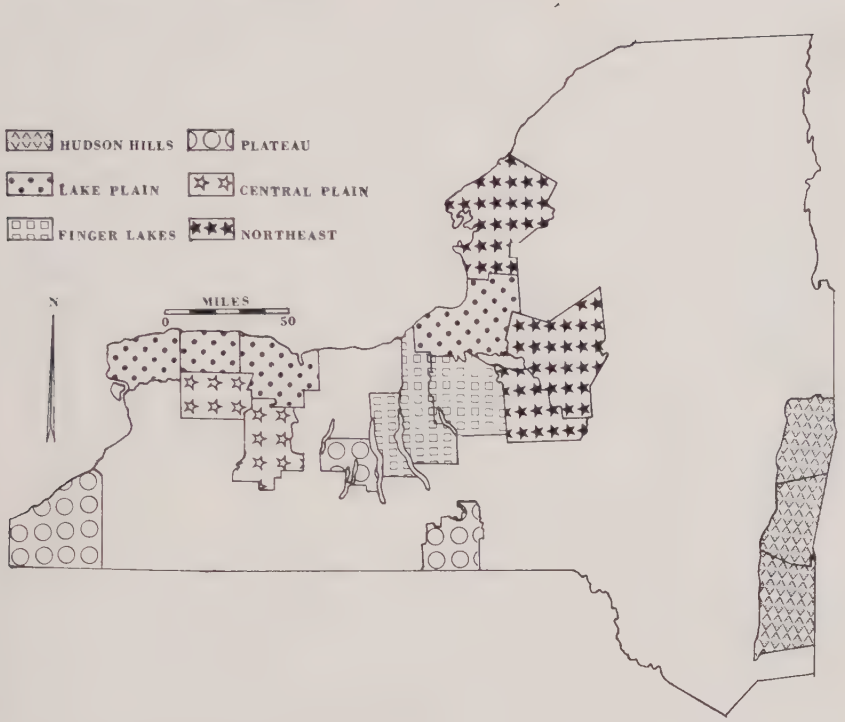

Figure 1. The six regions and 18 counties surveyed for bird damage to field corn in New York in 1971.

square-mile block, the first field encountered was selected for damage appraisal. Two plots, 100 feet long and one row wide, were randomly chosen within each field after determining field dimensions. Each 100-foot plot was subdivided into two 15-foot units and one 70-foot unit to allow comparisons of damage estimates from different-sized subplots.

Damage was appraised according to the method developed by De Grazio et al. (1969). The method is based on measurements of lengths of ears and lengths of damaged grain, and conversion of these measurements to weight loss through use of an empirical table. Plant density, stage of corn maturity, characteristics of bird damage, and damage caused by other animals were noted during the survey.

The 18 counties surveyed were grouped into six regions (Figure 1), based partly upon land-form regions described by Conklin and Linton (1969b) and partly upon corn-growing patterns determined during the survey.

RESULTS AND DISCUSSION

Estimated bird damage to field corn in each of the six regions sur-

Table 1. Field Characteristics and Estimated Bird Damage to Field Corn in Regions Sampled in New York in 1971

Region	Number counties sampled	Number fields sampled	Mean field size (acres)	Mean crop density (ears per 200 feet)	Mean loss* (bushels per acre)	Total acres planted to corn in 1970§
Hudson Hills	3	24	43.9	258	0.795 }	62,900
Finger Lakes	3	35	11.1	231	0.647 }	93,100
Lake Plain	4	29	19.4	223	0.618 }	70,700
Northeast	3	30	12.7	232	0.367	84,100
Plateau	3	18	9.1	196	0.121 }	45,800
Central Plain	2	23	18.7	236	0.067 }	60,500
Total	18	159	19.1	229	0.468	417,100

* Based on data from 100-foot plots; means bracketed are not siginificantly different ($P = 0.05$).

§ Includes all field corn in each county sampled in a region.

veyed is presented in Table 1. An analysis of variance indicated that there were differences among regions ($P<0.01$), and Duncan's multiple range test showed that bushel-per-acre losses were greatest in the Hudson Hills, Finger Lakes and Lake Plain regions, and least in the Plateau and Central Plain ($P = 0.05$). Differences in damage were not consistently related to the differences noted in agricultural characteristics (Table 1). However, the data suggest that, at extremes, plant density and field size may somewhat influence bird-damage patterns. This hypothesis requires further and more controlled testing than could be obtained in this study.

Red-winged blackbirds (*Agelaius phoeniceus*) were responsible for most of the damage observed. Puncture damage in all parts of cornfields and numerous observations of redwing flocks were evidence of this. In the Hudson Hills region, however, common grackles (*Quiscalus quiscula*) may have contributed as much as 40 per cent of the damage. Missing kernels, more characteristic of grackles, and observations of grackles in the area were evidence.

The estimated loss for the 18 counties in 1971 ($n = 159$ fields) was 0.468 bushel per acre, significantly less ($P < 0.01$) than the 1.842 bushels per acre estimated for the same 18 counties in the 1970 national survey ($n = 46$ fields). In 1970, samples were quite small in some regions and based on two 15-foot plots per field. However, data presented in Table 2 suggest that bird damage in 1971 was generally less severe than that in 1970. Lower bushel-per-acre losses and a lower percentage of ears damaged in 1971 in most regions indicate less bird pressure per field. The fact that a greater percentage of the fields

TABLE 2. COMPARISON OF 1970 AND 1971 SURVEYS OF BIRD DAMAGE TO FIELD CORN IN NEW YORK

Region	Fields surveyed		Fields damaged (per cent)		Ears examined		Ears damaged (per cent)		Mean loss (bushels per acre)	
	1970*	1971	1970	1971	1970	1971	1970	1971	1970	1971
Hudson Hills	4	24	100.0	87.5	120	6,199	8.33	7.65	1.303	0.795
Finger Lakes	14	35	57.1	74.3	546	8,105	11.35	10.19	2.413	0.647
Lake Plain	10	29	60.0	69.0	295	6,471	15.25	12.35	3.302	0.618
Northeast	7	30	71.4	83.3	246	6,950	19.92	8.65	1.687	0.367
Plateau	5	18	80.0	50.0	352	3,535	2.27	3.20	0.219	0.121
Central Plain	7	23	42.9	60.9	292	5,423	1.71	2.65	0.238	0.067
Total	47	159	63.8	72.3	1,851	36,683	9.67	8.11	1.842	0.468

* Includes only 18 counties showing bird damage in 1970.

examined showed bird damage in 1971 than in 1970 (despite a much larger sample size in 1971) suggests that the birds may have been more dispersed in 1971. Possible reasons for less damage per acre in 1971 are increased corn acreage, delayed corn maturation, a mild fall that resulted in delayed bird migration into corn areas, lower populations of local birds, the somewhat earlier survey dates in 1971, or any combination of these.

The most important factors probably were the very mild fall and increased corn planting to compensate for anticipated damage by southern leaf blight. According to one source (Anonymous, 1971) corn harvested for grain in New York was expected to increase 20 per cent, and the total acreage planted was up 8 per cent over 1970. Grain is apt to be more vulnerable to birds because harvest dates are later than for silage corn. Much of the New York corn crop is used for silage according to the Statistical Reporting Service of the U. S. Department of Agriculture (personal communication), and this corn was apparently harvested more rapidly in 1971 than in 1970. However, greater available acreages of grain corn during the depredations period in 1971, as a result of delayed maturation, may have resulted in less damage per acre. Delayed fall flocking of locally raised birds as a result of mild fall weather in 1971 may also have helped to keep the birds dispersed.

It seems unlikely that the somewhat earlier survey dates in 1971 accounted for the reduced damage. Corn development in 1971 was apparently 1 to 2 weeks behind that in 1970, but by early October most ears were hard. Very few of the 159 fields examined were still in the dough stage of corn development. Redwings prefer the earlier stages in corn development, and most of the damaged kernels observed were punctured in the manner characteristic of redwings (Figure 2).

Figure 2. Characteristic puncture damage to corn caused by red-winged blackbirds.

Low local populations of redwings were probably not a major factor in the reduced damage noted. Censuses conducted by Noel Cutright (personal communication) near Montezuma National Wildlife Refuge suggested that breeding males were present in similar numbers in 1970 and 1971. There is no reason to suspect that fewer redwings were produced in New York in 1971, since the breeding season was apparently similar to that in 1970. The contribution of locally raised redwings to corn damage in New York is not known, but such birds probably account for most of the damage in the Finger Lakes area (Cutright, personal communication) which manifested considerably less damage in 1971 than in 1970 (Table 2). It is likely that the formation of large autumn flocks depends partly on weather and partly on available food, both of which were more favorable in 1971. The extremely mild autumn in 1971 may also have delayed redwing movement into the State and contributed to the greatly reduced damage in the Lake Plain and northeast regions (Table 2), both of which lie in the path of New York's major blackbird flyway.

A comparison of damage estimates obtained from 15-foot plots and 100-foot plots is presented in Table 3. Predicted total bushel-per-acre losses and standard deviations from both plot sizes were similar. However, error variances (indicative of the variablity contributed by differ-

TABLE 3. COMPARISON OF DATA FROM 15-FOOT AND 100-FOOT PLOTS IN 1971 SURVEY OF BIRD DAMAGE TO FIELD CORN IN NEW YORK

Plot size	Mean loss of corn*	Error variance§	Total variance contributed by differences among ears (per cent)	Sample size (ears)
15-foot	0.451 ± 0.946	13.022	93.5	3,412
100-foot	0.468 ± 1.005	9.451	66.5	34,775

* Bushels per acre plus or minus standard deviation.

§ Mean square in analysis of variance; indicative of variance contributed by differences in the corn ears themselves.

ences among corn ears) were significantly different according to Bartlett's test for homogeneity of variances (chi-square = 174.1, $P < 0.001$). The variance resulting from differences among corn ears was a much more important component of total variance in the 15-foot plots (93.5 per cent of total) than in the 100-foot plots (63.5 per cent of total). The relative size of the error term is important because it is related to efficiency in *F*-tests. Thus, 100-foot plots were about 32 per cent more efficient in estimating damage than 15-foot plots. Since differences among plots within a field were not significant, a single 100-foot plot per field could be appraised in future surveys, providing damage is as consistent within each field as was the case in this survey.

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GENERAL NOTES

FIRST RECORD OF THE FOUREYE BUTTERFLYFISH FROM NEW YORK WATERS[1]

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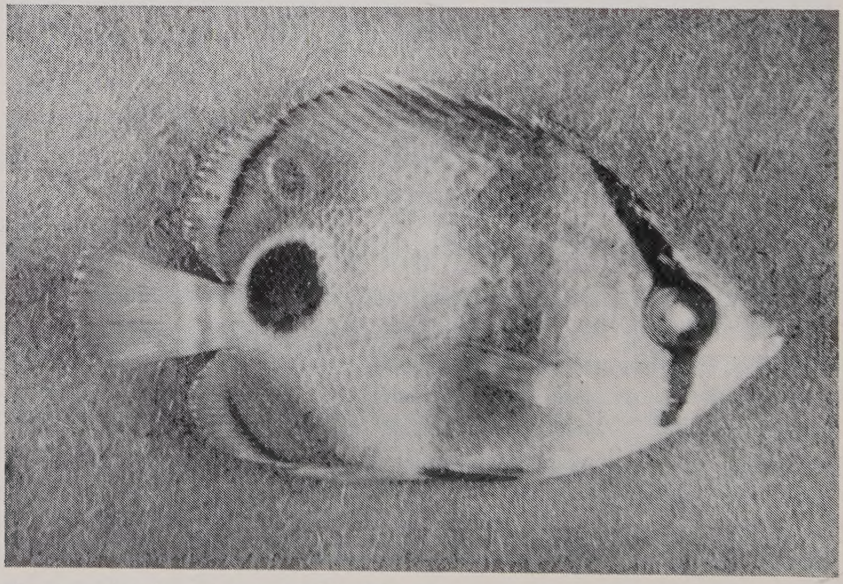
Conservation and Waterways

On September 16, 1969 a foureye butterflyfish (*Chaetodon capistratus*) was collected by the junior author from the Town of Hempstead Marina basin on Reynolds Channel at Point Lookout on the south shore of Long Island. The specimen was 35 millimeters in total length. At the time of capture, the water temperature was 20.8° C. (approx. 69° F.) and the salinity was 31.2 ppt.

Although there are several published records of this species from Woods Hole, Massachusetts, reported as *C. bricei* and *C. striatus* by Smith (1898, 1899, 1901) and as *C. capistratus* by Kendall (1908) and Summer et al. (1913), as well as a single record from Ventnor, New Jersey (Fowler, 1952), a review of the faunal literature for New York revealed none from local waters.

In commenting on the distribution of the species in the New York and southern New England area, Nichols and Breder (1926) noted only that it is "usually rare,



First recorded foureye butterflyfish (*Chaetodon capistratus*) from New York waters.

occasionally in some numbers to the eastward, in late summer and fall." It seems most probable that the current specimen was transported to New York as a larval

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drifter from more southern waters, e.g., from the vicinity of the Bahamas where *C. capistratus* is the most common of the butterflyfishes (Böhlke and Chaplin, 1968).

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OCCURRENCE OF A LOOKDOWN IN THE HUDSON RIVER

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On October 13, 1971 a single specimen of the lookdown (*Selene vomer*) was collected from the Hudson River at Indian Point. The fish was recovered from traveling screen #14 at the water intake of the Indian Point Unit 1 Generating Station. The specimen was 70 millimeters long (standard length) and weighed 10 grams. The fish was dead when collected, but the carcass was in excellent physical condition indicating that it had died recently.

At the time of collection, the water temperature was 20° C. and the salinity was 2.4 ppt. On October 15, 1970 a fish that appeared to be a lookdown was collected at the Unit 1 intake; however, the specimen was too decomposed for positive identification.

The lookdown is a tropical marine species that is common from Chesapeake Bay southward to Uruguay. It has been reported straying north to Cape Cod, the Gulf of Maine and Nova Scotia (Bigelow and Schroeder, 1953). Previously unreported from the Hudson River, it is known to occur in the coastal waters of New York. Nichols and Breder (1926) reported the lookdown as uncommon in the New York area from August through October and "not rare" in Sandy Hook Bay.

Perlmutter (personal communication) reported finding the lookdown in the coastal waters of Long Island but stated that its occurrence was sporadic from year to year. It was not included by Curran and Ries (1937) in a list of marine forms found in the lower Hudson River.

During late summer and fall there is a movement of marine species into the lower Hudson River, brought about by the seasonal low in freshwater runoff which permits seawater to intrude upstream beyond Indian Point. The lookdown is a previously unreported member of this movement of marine species.

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